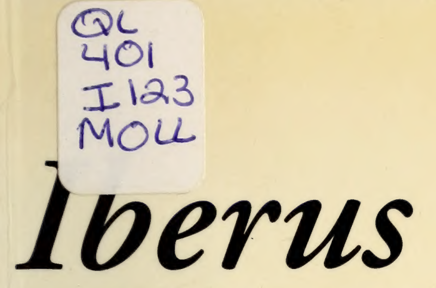


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Vol. 21 (1)

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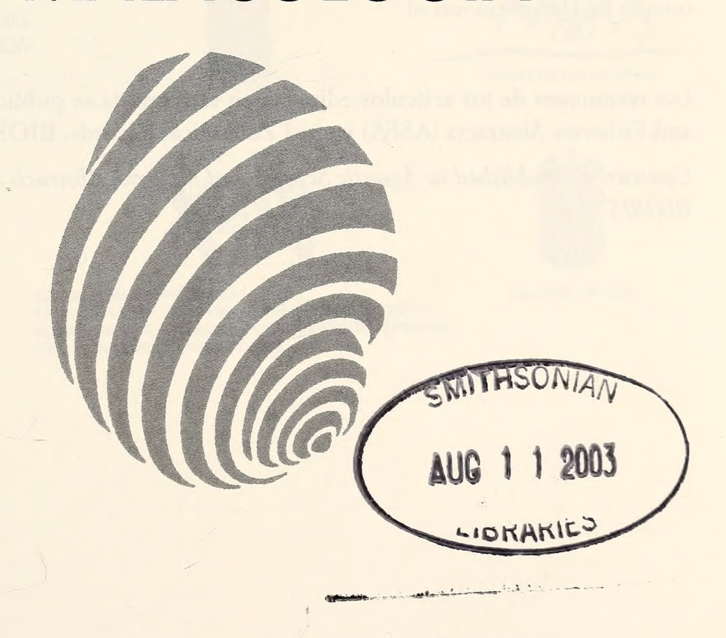
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REVISTA DE LA SOCIEDAD ESPAÑOLA DE MALACOLOGÍA



Vol. 21 (1) **Oviedo, junio 2003**

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Los resumenes de los artículos editados en esta revista se publican en Aquatic Science and Fisheries Abstracts (ASFA) y en el Zoological Records, BIOSIS.

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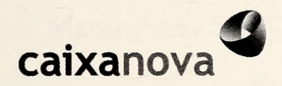
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ISSN 0212-3010

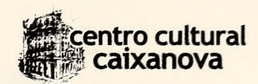
Diseño y maquetación: Gonzalo Rodríguez

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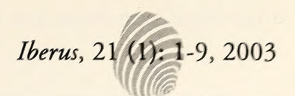
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Concello de Vigo

Este número contiene algunos trabajos presentados en el II Congreso Internacional de las Sociedades Malacológicas Europeas, celebrado en Vigo, del 9 al 13 de Septiembre de 2002, habiendo sido parcialmente subvencionado por las ayudas a dicho Congreso

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Four new species of *Latirus* (Gastropoda: Fasciolariidae) from the Philippine Islands and the southern Caribbean

Cuatro nuevas especies de *Latirus* (Gastropoda: Fasciolariidae) de Filipinas y el Caribe sur

Martin Avery SNYDER*

Recibido el 15-III-2002. Aceptado el 1-VIII-2002

ABSTRACT

This paper describes four *Latirus* species in the neogastropod family Fasciolariidae, *Latirus cloveri*, *Latirus sarinae*, and *Latirus philippinensis*, all from the Philippine Islands, and *Latirus abbotti* from the southern Caribbean. *Latirus cloveri* is distinguished from *Fasciolaria walleri* Ladd, 1976, also from the Philippine Islands, *Latirus sarinae* from *Latirus kandai* Kuroda, 1950 from the western Pacific, *Latirus philippinensis* from *Latirus elsiae* Kilburn, 1975 from South Africa, and *Latirus abbotti* from *Latirus angulatus* (Röding, 1798) from the Caribbean.

RESUMEN

Se describen cuatro especies de Latirus pertenecientes a la familia Fasciolariidae, *Latirus cloveri*, *Latirus sarinae*, y *Latirus philippinensis*, procedentes de Filipinas, y *Latirus abbotti* del Caribe sur. *Latirus cloveri* se diferencia de *Fasciolaria walleri* Ladd, 1976, también de Filipinas, *Latirus sarinae* de *Latirus kandai* Kuroda, 1950 del Pacífico oeste, *Latirus philippinensis* de *Latirus elsiae* Kilburn, 1975 de Sudáfrica, y *Latirus abbotti* de *Latirus angulatus* (Röding, 1798) del Caribe.

KEY WORDS: Mollusca, Gastropoda, Fasciolariidae, *Latirus*, new species.
PALABRAS CLAVE: Mollusca, Gastropoda, Fasciolariidae, *Latirus*, nuevas especies.

INTRODUCTION

These four new species of *Latirus* from the Philippine Islands and from the Caribbean are new discoveries from areas where several new species of *Latirus* have been described in recent years. Tangle net collecting in the Philippine Islands has resulted in the discovery of many new molluscan species including *Latirus aldeynzeri* Garcia, 2001, *L. balicasagensis* Bozzetti, 1997 and *L. martinorum* Cernohorsky, 1987. Many new species have also been discovered recently in the Caribbean, especially around Honduras, including "*Latirus anapetes*" (Woodring) Petuch, 1981, *L. martini* Snyder, 1988 and *L. cuna* Petuch, 1990. Almost all of the material described herein was or is part of the author's collection. These specimens were collected in the last 10 years, either as a byproduct of commercial fishing operations or by scuba diving.

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Abbreviations used

ANSP Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, USA
EC Everson collection, Louisville, Kentucky, USA
MNHN Muséum national d'Histoire naturelle, Paris, France
SC Snyder collection, Villanova, Pennsylvania, USA
USNM National Museum of Natural History, Smithsonian Institution, Washington D.C., USA

SYSTEMATICS

Family FASCIOLARIIDAE Gray, 1853
Subfamily PERISTERNIINAE Tryon, 1880
Genus *Latirus* Montfort, 1810

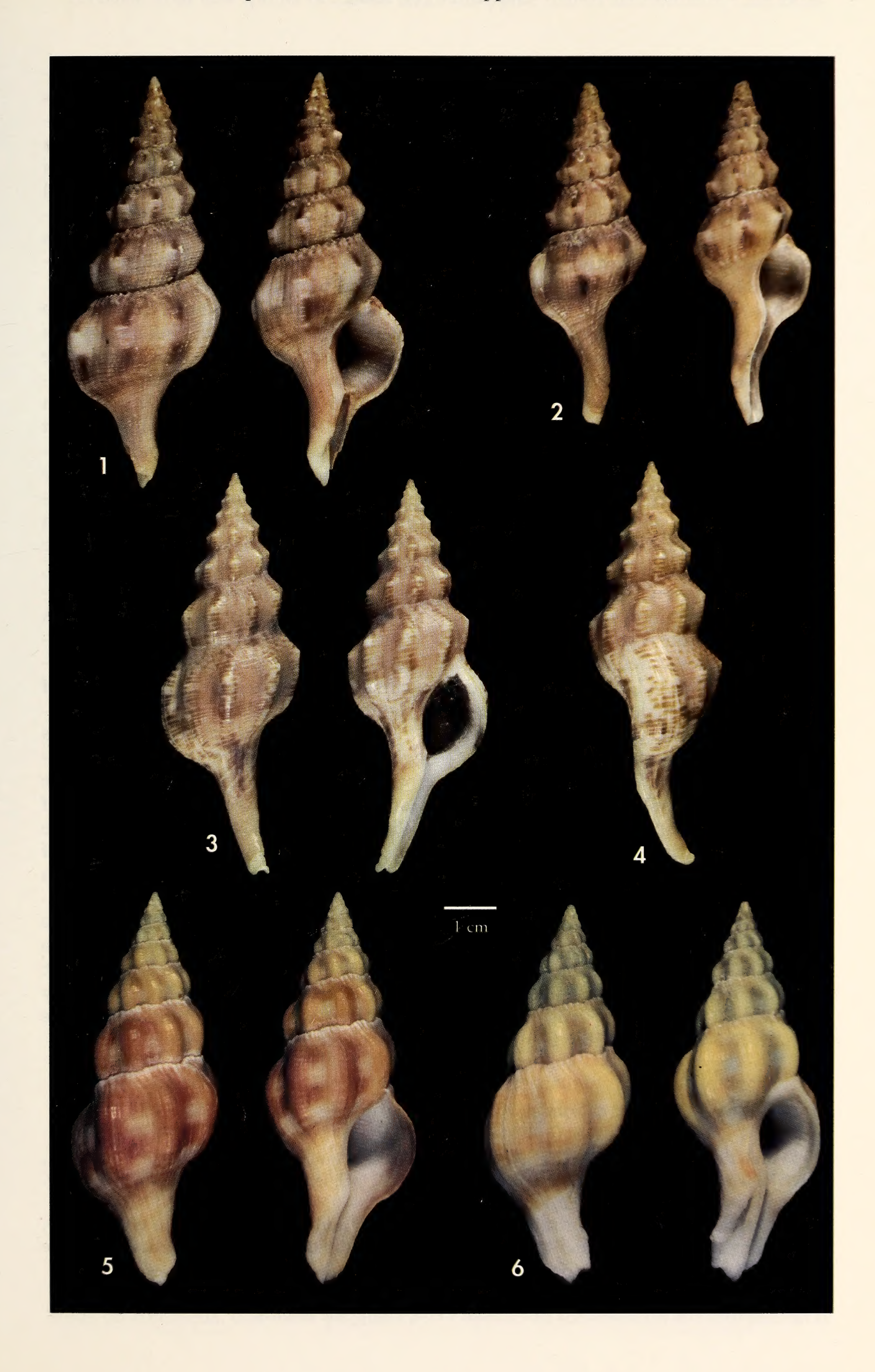
Type species: *Latirus aurantiacus* Montfort, 1810, a synonym of *Latirus gibbulus* (Gmelin, 1791), Recent, Indo-Pacific, by monotypy.

Latirus cloveri spec.nov. (Figs. 1, 2)

Type material: Holotype ANSP 408331, length 52.7 mm, in tangle nets, depth 150 m. Paratype 1, MNHN, length 40.4 mm, subadult, in tangle nets, Balicasag Island, Bohol, Philippine Islands. Paratype 2, SC, length 49.6 mm, from type locality. Paratype 3, SC, length 48.1 mm, from type locality.
Other material examined: 1 adult specimen 64.5 mm and 3 immature specimens, 34.2 mm, 38.7 mm, 43.3 mm, the first apparently live collected, all SC. 38.7 mm specimen from type locality; others from tangle nets off Panglao, Bohol, Philippine Islands.
Etymology: The species is named for Phillip Clover of Glen Ellen, California, a friend and shell dealer, who provided much of the type material.
Type locality: Aliguay Island, off Dipolog, northwest Mindanao, Philippine Islands.

Description: Shell medium size for genus, fusiform, length of adult specimens from 48.1 mm to 64.5 mm. Siphonal canal short, narrowly open, curved, often twisted away from aperture. Smooth pearly white protoconch of 1 1/4 to 1 1/2 whorls, with 8-9 additional whorls. Sculpture begins on first teleoconch whorl, which is also pearly white; balance of teleoconch colored light tan to brown. Teleoconch sculpture of 7-8 narrow axial ribs per whorl with sharply angular nodes at shoul-

(Right page) Figure 1. *Latirus cloveri* spec. nov. Holotype. ANSP 408331, (52.7 mm), from tangle nets off Aliguay Island, off Dipolog, northwest Mindanao, Philippine Islands, depth 150 m. Figure 2. *Latirus cloveri* spec. nov. Paratype 1. SC (40.4 mm), from tangle nets, Balicasag Island, Bohol, Philippine Islands. Figures 3, 4. *Fasciolaria walleri* Ladd, 1976. SC (51.3 mm), in tangle nets at night, Cebu, Philippine Islands, depth 130 m. Figure 5. *Latirus sarinae* spec. nov. Holotype. ANSP 408332, (50.5 mm), from tangle nets off Mactan Island, Cebu, Philippine Islands, depth 160 m. Figure 6. *Latirus sarinae* spec. nov. Paratype 1. MNHN (48.9 mm), from type locality.
(Página derecha) Figura 1. Latirus cloveri *spec. nov. Holotipo. ANSP 408331, (52,7 mm), de redes de cerco frente a Aliguay Island, frente a Dipolog, noroeste de Mindanao, Filipinas, profundidad 150 m. Figura 2.* Latirus cloveri *spec. nov. Paratipo 1. SC (40,4 mm), de redes de cerco, Balicasag Island, Bohol, Filipinas. Figuras 3, 4.* Fasciolaria walleri *Ladd, 1976. SC (51,3 mm), en redes de cerdo de noche, Cebu, Filipinas, profundidad 130 m. Figura 5.* Latirus sarinae *spec. nov. Holotipo. ANSP 408332, (50,5 mm), de redes de cerco frente a Mactan Island, Cebu, Filipinas, profundidad 160 m. Figura 6.* Latirus sarinae *spec. nov. Paratipo 1. MNHN (48.9 mm), de la localidad tipo.*


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ders crossed by numerous fine spiral cords, axial ribs streaked white and dark brown, shoulder nodes usually white. Suture deeply impressed with imbricate scaly projections from abapically contiguous whorl. Aperture ovate, lirate within, interior of aperture pink to purple-brown with about 25-30 lirations stopping short of smooth labral margin. Lip moderately thick with minute dentations terminating in internal lirations. Columella smooth with one reasonably prominent plica at abapical end of aperature by canal; small ridge on lip approximately opposite plica.

Distribution: *Latirus cloveri* has been collected in tangle nets at various locations in the central Philippine Islands.

Discussion: This species was figured and discussed by SPRINGSTEEN AND LEOBRERA (1986: 332, pl. 94, fig. 12) as "*Fasciolaria*" *walleri* Ladd, 1976 (teratological) although they mention that "it may represent a good taxon." These authors state that it is "almost morphologically indistinguishable" from *Fasciolaria walleri* (Figs. 3, 4) which they redescribe from Recent material (177, pl. 47, fig. 17). However, apart from the shoulder nodules, which are more rounded and less prominent in *F. walleri*, and the suture, free of the scaly projections in *F. walleri*, there are other differences worth noting. The color pattern of *F. walleri* is a random mix of segments of brownish axial stripes and vertical stripes, especially on the body whorl, against a pale brown background color; the coloration is much less pronounced than in *L. cloveri*. The canal of *F. walleri* is proportionally longer, straighter and often more strongly recurved than in *L. cloveri*.

The status of *Fasciolaria walleri* deserves comment. LADD (1976: 133, figs. 16-20) described this species based upon Pleistocene material from the New Hebrides Islands, and placed it in the subgenus *Pleuroploca*. Subsequently (LADD, 1982: 47) he transferred the species to *Siphonofusus* [Buccinidae], while noting a superficial resemblance to the fasciolariid genus *Granulifusus*. Later, BEETS (1987: 90) placed this species in *Buccinulum* (*Euthria*) [Buccinidae] and described a subspecies *B. walleri sedanense*. These placements were based on fossil material. This species was subsequently discovered living in the Philippine Islands (SPRINGSTEEN AND LEOBRERA, 1986: 177, pl. 47, fig. 17). Although this species has been collected alive, no soft parts have been preserved and no definitive generic or familial placement can be made at this time. One subadult specimen was obtained with an operculum which presumably corresponds to the shell. This operculum, ovate and corneus, light brown, size and shape corresponding to aperature, with terminal nucleus, is consistent with assignment as a fasciolariid, as is the dentate lip (which buccinids of this size lack) and the lack of determinate growth.

The final generic placement of *Latirus cloveri* is also problematic. At the beginning of the siphonal canal there is a ridge on the inside of the lip, reminiscent of *Siphonofusus lubrica* (Dall, 1918), the type of *Siphonofusus* [Buccinidae]. The shell of *L. cloveri* is not entirely consistent with placement in either *Latirus* or *Fusinus* although it is apparently a fasciolariid. One should also note the dentate lip and the lack of determinate growth. GOFAS (2000: 15) has noted that columellar folds may not be an absolute differentiator for the genera *Fusinus* and *Latirus*.

Latirus sarinae spec. nov. (Figs. 5, 6)

Type material: Holotype ANSP 408332, length 50.5 mm, in tangle nets, depth 160 m. Paratype 1, MNHN, length 48.9 mm, from type locality. Paratype 2, SC, length 55.0 mm, from type locality. No live collected specimens seen; all type material adult.

Other material examined: Four subadult specimens, 34.7 mm and 37.3 mm, from type locality, and two specimens, 31.3 mm and 44.3 mm, from tangle nets off Balicasag Island, Bohol, Philippine Islands (all SC).

Etymology: The species is named for the author's daughter, Sarina.

Type locality: Mactan Island, off east central Cebu, Philippine Islands.

Description: Shell medium size for genus, fusiform, length of adult specimens from 48.9 mm to 55.0 mm. Siphonal canal short, straight, angled from apertural plane, umbilicus open in larger specimens but as slit on smaller specimens. Smooth whitish protoconch of approximately 1 whorl, eroded on most specimens; teleoconch of 8-9 whorls with 8 heavy rounded axial ribs per whorl. Ribs on teleoconch solidly colored yellow-orange to orange-brown, interstices between with longitudinal bands of predominate shell color interspersed with white bands, 6-7 such bands on body whorl with narrow white band by suture, siphonal canal mostly white. Weak spiral cords most visible crossing axial ribs, with weaker axial lines. Suture impressed with white imbricate dentation from abapically contiguous whorl. Aperture ovate, lip weakly dentate, thin at edge and thickened within, aperture lirate within after 4 mm smooth inner lip. Columella smooth with one plica with traces of a second plica in some specimens.

Distribution: *Latirus sarinae* has been collected in tangle nets at various locations in the central Philippine Islands.

Discussion: *Latirus sarinae* is morphologically closest to *L. kandai* Kuroda, 1950 (Fig. 7). This latter species was described from material collected off Cape Shirazaki, Kii Peninsula, Wakayama Prefecture, Japan, but is also collected in tangle nets in the Philippine Islands. *Latirus kandai* is smaller than *L. sarinae* and has more prominent spiral cords that are white against a uniformly orange-brown background color versus cords that are the same color as the axial ribs. The lip of *L. kandai* is weakly dentate and the aperture is lirate right up to the lip, whereas in *L. sarinae* these lirae are interrupted by a smooth labral margin. The protoconchs of both species are similar in form, indicating that *L. sarinae* may be a reasonably widespread species.

Latirus philippinensis spec. nov. (Figs. 8, 9)

Type material: Holotype ANSP 408333, length 54.8 mm, in tangle nets, depth 160 m. Paratype 1, MNHN, length 45.2 mm, in tangle nets, depth 160 m, Mactan Island, Cebu, Philippine Islands. Paratype 2, SC, length 45.3 mm, same data as paratype 1. No live collected specimens seen.
Etymology: The species is named for the area of discovery, the Philippine Islands.
Type locality: Balut Island, off southernmost Mindanao, Philippine Islands.

Description: Shell medium size for genus, fusiform, thin and elongate, length of adult specimens from 45 mm to 55 mm. Siphonal canal long, recurved. Smooth whitish protoconch, paucispiral of 1 $^{1}/_{4}$ whorls, teleoconch 9 whorls. Axial sculpture of teleoconch with prominent rounded ribs, 10 on body whorl, decreasing in number toward apex. Six spiral cords on first five whorls of teleoconch. On sixth whorl five additional weak cords between six strong cords, sixteen on penultimate whorl and numerous cords on body whorl continuing up full length of siphonal canal. Axial lines crossing cords cut surface into small squares. Suture slightly depressed. Three strong folds on columella, one more prominent than others. Aperture narrow and long, parietal shield glossy, overlaying body of shell, attached lip thin, weakly dentate, shiny within. Shell white with apical portion of early whorls brownish with additional central brown color band on body whorl, stripe visible inside lip on labral margin.

Distribution: *Latirus philippinensis* is known from just four specimens, all from the type locality.

Discussion: *Latirus philippinensis* cannot be confused with any other member of the genus. The very strong columellar folds resemble those of *Latiromitra* [Turbinellidae], but the teleoconch sculpture, with broad uncoronated ribs and numerous closely-shaped spiral cords, is unlike any species of *Latiromitra*. The color pattern of

L. philippinensis is unlike species of *Latiromitra* which are without color or bands. The protoconch is inconclusive for generic placement, and the other resemblances to *Latiromitra* are superficial. Although the radula alone would permit an unequivocal generic assignment, shell morphology suggests placement in *Latirus* rather than *Latiromitra*.

Latirus philippinensis is similar in size and shape to *Benimakia lanceolata* (Reeve, 1847) from the tropical Indo-Pacific but *B. lanceolata* has fewer axial ribs, a purple aperture and a straight canal. It somewhat resembles *L. elsiae* Kilburn, 1975 from South Africa but that species is not so elongate and is colored with axial brown streaks along the ribs rather than brown spiral bands. *L. philippinensis* is similar in shape to *Pseudolatirus discrepans* Kuroda and Habe, 1971 from Japan, and occasionally collected in tangle nets in the Philippine Islands, but *P. discrepans* grows much longer (to 87.5 mm), has very faint brown color bands, less prominent axial ribs on later whorls, and a straight canal. Finally, *L. philippinensis* may be compared to *Pseudolatirus clausicaudatus* (Hinds, 1844) from South Africa but this latter species lacks the prominent brown color bands, has a very small aperture with a peculiar thickened lip, and has a long, straight almost closed siphonal canal.

Latirus abbotti spec. nov. (Figs. 10, 11)

Type material: Holotype ANSP 408334, length 49.1 mm, on sand, depth 6 m. Paratype 1, USNM 1001651, length 26.0 mm, from type locality. Paratype 2, EC, length 52.1 mm, by scuba at night on turtle grass, depth 6 m, between Ragged Cay and Sandy Cay off Utila Island, Honduras. Paratype 3, SC, length 45.9 mm, under rubble, depth 3 m, Monte Cristi, Dominican Republic.

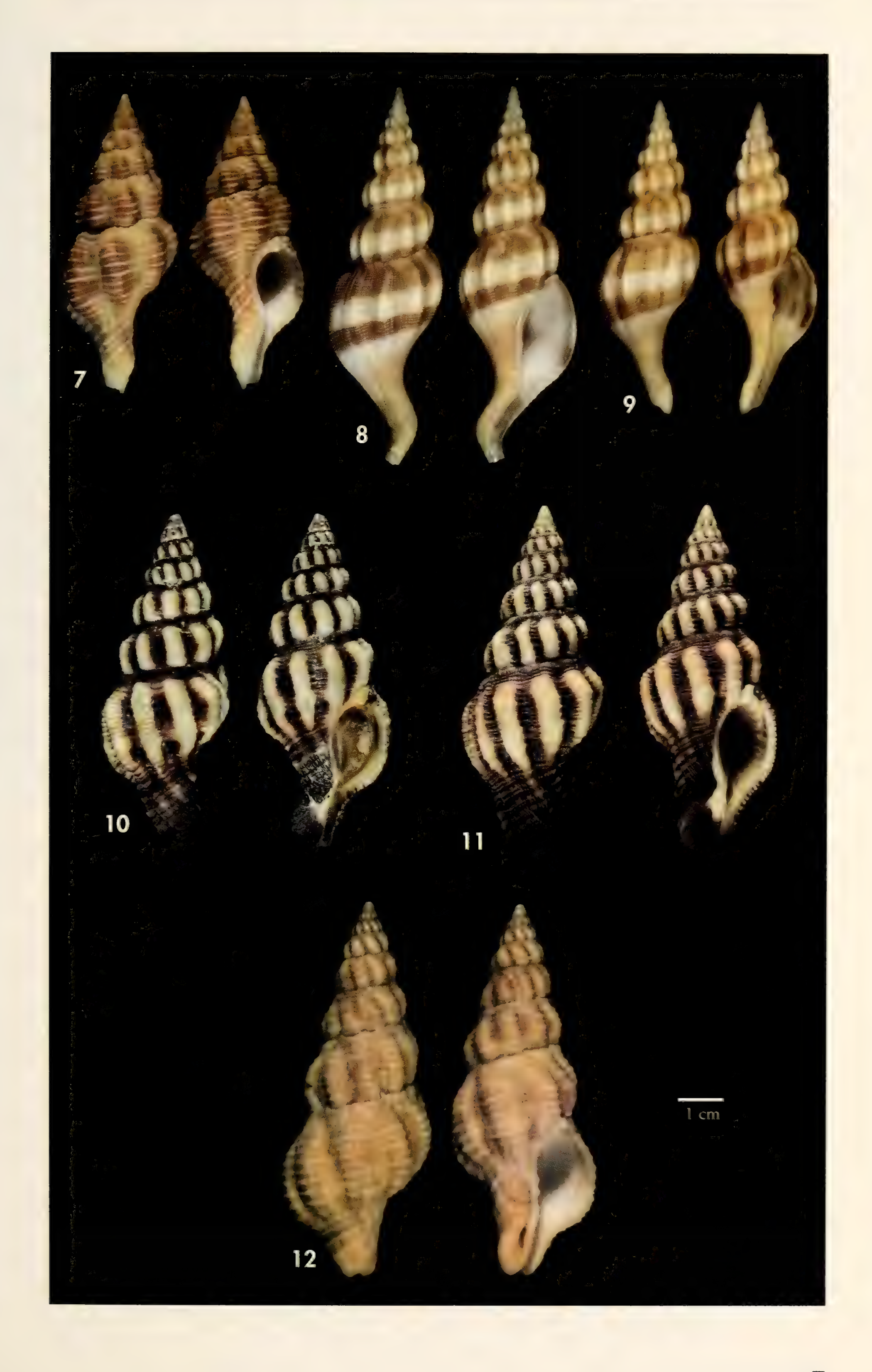
Other material examined: 4 immature specimens, 21.0 mm – 36.0 mm, Utila Island, Honduras; 8 immature specimens, 22.5 mm – 43.9 mm (largest specimen live collected), Roatan Island, Honduras; 2 immature specimens, 26.2 mm, 27.1 mm, Cayo Gorda, (Mesquitia) Honduras; 1 immature live collected specimen, 23.6 mm, Punta Rusia, north coast Dominican Republic; 2 immature specimens, 23.4 mm, 25.6 mm, Quita Sueno Bank, Nicaragua (all SC).

Etymology: The species is named in memory of R. Tucker Abbott, one of the foremost researchers on mollusks of America, and my early mentor.

Type locality: Utila Island, off north central Honduras.

(Right page) Figure 7. *Latirus kandai* Kuroda, 1950. SC (43.4 mm), in tangle nets, Panglao Island, off southwest Bohol, Philippine Islands, depth 160 m. Figure 8. *Latirus philippinensis* spec. nov. Holotype. ANSP 408333 (54.8 mm), in tangle nets, Balut Island, Cebu, Philippine Islands, depth 160 m. Figure 9. *Latirus philippinensis* spec. nov. Paratype 2. SC (45.3 mm), from tangle nets, Mactan Island, Cebu, Philippine Islands, depth 160 m. Figure 10. *Latirus abbotti* spec. nov. Holotype. ANSP 408334, (49.1 mm), on sand off Utila Island, Honduras, depth 6 m. Figure 11. *Latirus abbotti* spec. nov. Paratype 2. EC (52.1 mm), by scuba at night on turtle grass between Ragged Cay and Sandy Cay off Utila Island. Honduras, depth 6 m. Figure 12. *Latirus angulatus* (Röding, 1798). SC (54.7 mm), dived from sand, under rocks, Salvador, Bahia State, Brazil, depth 15-20 m.

(Página derecha) Figura 7. Latirus kandai *Kuroda, 1950. SC (43,4 mm), en redes de cerco, Panglao Island, al sudoeste de Bohol, Filipinas, profundidad 160 m. Figura 8.* Latirus philippinensis *spec. nov. Holotipo. ANSP 408333 (54,8 mm), en redes de cerco, Balut Island, Cebu, Filipinas, profundidad 160 m. Figura 9.* Latirus philippinensis *spec. nov. Paratipo 2. SC (45,3 mm), en redes de cerco, Mactan Island, Cebu, Filipinas, profundidad 160 m. Figura 10.* Latirus abbotti *spec. nov. Holotipo. ANSP 408334, (49,1 mm), en arena frente a Utila Island, Honduras, profundidad 6 m. Figura 11.* Latirus abbotti *spec. nov. Paratipo 2. EC (52,1 mm), de buceo nocturno sobre* Thalassia testudinum *entre Ragged Cay y Sandy Cay frente a Utila Island. Honduras, profundidad 6 m. Figura 12.* Latirus angulatus *(Röding, 1798). SC (54,7 mm), arena, bajo rocas, Salvador, Bahia, Brasil, profundidad 15-20 m.*


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Description: Shell medium size for genus, fusiform, length of adult specimens from 45.9 mm to 52.1 mm. Siphonal canal short, straight, angled at approximately 22° from axis of aperture, colored brown to blackish-brown. Smooth, cream-colored, bulbous protoconch of about 1 whorl and teleoconch of 8-9 whorls. Sculpture of teleoconch with 10-11 prominent rounded white to cream-colored axial ribs with dark brown interstices, converging above ribs on body whorl to color canal dark brown. Numerous reddish-brown spiral cords crossing axial ribs; some specimens with a single white band circling from anal canal around body whorl to approximate center of lip; band may follow suture between penultimate and body whorl and then becomes evanescent. At suture, ribs terminate with a brown band above. Columella with two prominent plicae and an additional smaller plica at beginning of canal. Aperture narrowly elongate, lirate with thick weakly dentate lip; sometimes bright yellow within when freshly collected. Umbilicus open only on large specimens.

Distribution: *Latirus abbotti* has been widely collected in the southwestern Caribbean.

Discussion: This distinctive species is easily differentiated from known Caribbean species of *Latirus*. The unusual coloration and numerous axial ribs are an immediate distinguishing characteristic. The closest species morphologically is *Latirus angulatus* (Röding, 1798) which has an elongate form (Fig. 12) from Cuba and South America (see as well BULLOCK (1974: 74-76, fig. 20)). *Latirus angulatus* has just 7-8 axial ribs on each whorl compared to 10-11 in *L. abbotti* and has an orange to orange-brown background with lighter longitudinal cords; the color is uniform throughout whereas in *L. abbotti* is brown with lighter often whitish ribs.

ACKNOWLEDGEMENTS

Gary Rosenberg and Geerat Vermeij offered helpful suggestions regarding these new species. Philippe Bouchet offered a helpful discussion concerning *Latiromitra*. Sarah Watson took the digital photographs and composed the plates.

BIBLIOGRAPHY

BEETS, C., 1987. Notes on *Buccinulum* (Gastropoda, Buccinidae), a reappraisal. *Scripta Geologica*, 82: 83-100, pls. 6, 7, (1986). [Dated in internal heading as January, 1987].

BOZZETTI, L., 1997. Study of the collection of Mr. Emmanuel Guillot de Suduiraut with the descriptions of three new gastropod species (Fasciolariidae, Trochidae and Turridae). *Bulletin of the Institute of Malacology*, Tokyo 3 (4): 55-58.

BULLOCK, R. C., 1974. A contribution to the systematics of some West Indian *Latirus* (Gastropoda: Fasciolariidae). *The Nautilus*, 88 (3): 69-79.

CERNOHORSKY, W. O., 1987. The taxonomy of some Indo-Pacific Mollusca. Part 14, with descriptions of two new species. *Records of the Auckland Institute and Museum*, 24: 107-122, figs. 1-33.

DALL, W. H., 1918. Notes on *Chrysodomus* and other mollusks from the north Pacific Ocean. *Proceedings of the United States National Museum*, 54 (2234): 207-234.

GARCÍA, E. F., 2001. A new species of *Latirus* (Gastropoda: Fasciolariidae) from the southern Philippines. *Novapex*, 2 (4): 149-151, figs. 1-4, 1 text fig.

GOFAS, S., 2000. Four species of the family Fasciolariidae (Gastropoda) from the north Atlantic seamounts. *Journal of Conchology*, 37 (1): 7-16, figs. 1-3.

KILBURN, R. N., 1975. Taxonomic notes on South African marine Mollusca (5), including descriptions of new taxa of Rissoidae, Cerithiidae, Tonnidae, Cassidae, Buccinidae, Fasciolariidae, Turbinellidae, Turridae, Architectonicidae, Epitoniidae, Limidae and Thraciidae. *Annals of the Natal Museum*, 22 (2): 577-622, figs. 1-25.

KURODA, T., 1950. Descriptions of two new species of marine gastropods, dedicated to Mr. K. Kanda on his 77th birthday. *Venus*, 16 (1-4): 49-52.

KURODA, T. AND HABE, T., 1971. [Descriptions of genera and species] *In:* T. Kuroda, T. Habe and K. Ōyama. *The Sea Shells of Sagami Bay*. Tōkyō: Maruzen. xix, 741 pp. [Japanese text], 121 pls., 489 pp. [English text], 51 pp., index, map.

LADD, H. S., 1976. New Pleistocene Neogastropoda from the New Hebrides. *The Nautilus* , 90 (4): 127-138.

LADD, H. S., 1982. Cenozoic fossil mollusks from west Pacific islands; Gastropods (Eulimidae and Volutidae through Terebridae). *United States Geological Survey Professional Paper*, 1171: i-iv, 1-100, pls. 1-41.

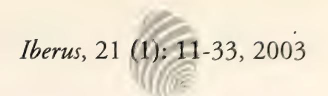
PETUCH, E. J., 1981. A relict neogene caenogastropod fauna from northern South America. *Malacologia* , 20 (2): 307-347.

PETUCH, E. J., 1990. A new molluscan faunule from the Caribbean coast of Panama. *The Nautilus*, 104 (2): 57-71.

SNYDER, M. A., 1988. *Latirus martini* (Gastropoda: Fasciolariidae), a new species from Honduras. *The Nautilus*, 102 (2): 54-55.

SPRINGSTEEN, F. J. AND LEOBRERA, F. M., 1986. *Shells of the Philippines*. Manila: Carfel Seashell Museum. 377 pp., 100 pls.

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The littoral molluscs (Gastropoda, Bivalvia and Polyplacophora) of São Vicente, Capelas (São Miguel Island, Azores): ecology and biological associations to algae

Los moluscos litorales (Gastropoda, Bivalvia y Polyplacophora) de São Vicente, Capelas (São Miguel Island, Azores): ecología y asociaciones biológicas con algas

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Recibido el 12-IV-2002. Aceptado el 26-VIII-2002

ABSTRACT

A two-year systematic survey was conducted in a rocky exposed shore located at Porto das Baleias (São Vicente, Capelas) in the north coast of São Miguel Island and supposedly representative of the Azorean rocky shores. Zonation of the littoral molluscs (Gastropoda, Bivalvia and Polyplacophora) was established for the most abundant species and possible molluscs/algae biological associations were studied.

Seventy-one taxa (56 Gastropoda, 13 Bivalvia and 2 Polyplacophora) were found in the 1996 and 1997 fieldwork, with a total of 35,960 specimens recorded. *Bittium* sp., an Azorean endemism, was the commonest taxon, with 11,936 and 12,374 individuals (61.1% and 75.4%, respectively in 1996 and 1997). Thirteen taxa accounted for about 96% of the total of specimens collected in both years. Some differences in the relative abundance of the commonest taxa were found between the two years. Besides *Bittium* sp., the next most abundant taxa in 1996 were *Tricolia pullus azorica* (14,0%), *Jujubinus pseudogravinae* and *Manzonia unifasciata*, both with 4%, and *Parvicardium vroomi, Alvania sleursi* and *Crassadoma pusio*, all between 2-3%. In 1997, *P. vroomi* and *T. pullus azorica* (6,4% and 6,1%) were the most abundant species after *Bittium* sp., followed by *Alvania sleursi* and *Jujubinus pseudogravinae* with a little more than 1% of the total number of molluscs collected in that year.

The endemic rissoids *Alvania angioyi, Manzonia unifasciata* and *Rissoa guernei*, the also endemic trochid *Gibbula delgadensis*, the Macaronesian *Anachis avaroides* and the small bivalve *Parvicardium vroomi* were only abundant in shallow levels (down to 5-6m), whereas the endemic rissoid *Alvania sleursi* is especially abundant below 20m depth. *Bittium* sp., *Tricolia pullus azorica* and *Jujubinus pseudogravinae* were found along all transect. No specific molluscs/algae associations were found.

RESUMEN

Se investigó durante dos años un tramo de costa rocosa expuesta en Porto das Baleias (São Vicente, Capelas) en la costa norte de São Miguel que se suponía respresentativa de las costas rocosas azoreanas. Se estableció la zonación de los moluscos litorales (Gastro-

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poda, Bivalvia y Polyplacophora) más abundantes y se estudiaron posibles asociaciones moluscos/algas.
Se encontraron 71 táxones (56 Gastropoda, 13 Bivalvia y 2 Polyplacophora) durante los años 1996 y 1997. Bittium sp., un endemismo azoreano, fue la especie más abundante (61,1 % y 75,4 % del total en el 96 y 97 respectivamente). Trece especies representaron el 96% del total de especimenes recolectados en ambos años. Tras Bittium sp, los táxones más abundantes en el 96 fueron *Tricolia pullus azorica* (14,0%), *Jujubinus pseudogravinae* y *Manzonia unifasciata*, ambos con el 4%, y *Parvicardium vroomi*, *Alvania sleursi* y *Crassadoma pusio*, entre el 2 y 3%. En el 97, tras Bittium sp. aparecen *P. vroomi* y *T. pullus azorica* (6,4% y 6,1%), seguidos de *Alvania sleursi* y *Jujubinus pseudogravinae* con algo más del 1%.
Los risoideos endémicos *Alvania angioyi*, *Manzonia unifasciata* y *Rissoa guernei*, el también endémico trocoideo*Gibbula delgadensis*, *Anachis avaroides* y el pequeño bivalvo *Parvicardium vroomi* solo son abundantes en los niveles someros (hasta 5-6m), mientras que *Alvania sleursi* es especialmente abundantes por debajo de 20 m. *Bittium* sp., *Tricolia pullus azorica* y *Jujubinus pseudogravinae* se encontraron a lo largo de todo el transecto No se encontró ninguna asociación molusco/alga

KEY WORDS: Mollusca, Azores, littoral, ecology, biological associations.
PALABRAS CLAVE: Mollusca, Azores, litoral, ecología, asociaciones biológicas.

INTRODUCTION

The first authors who studied the marine molluscs of the Azores - MAC ANDREW (1856), DROUËT (1858), MORELET (1860), DAUTZENBERG AND FISCHER (1896) and NOBRE (1924; 1930) – were mainly concerned with the publication of commented checklists. The most complete work with such a methodology is still the classic first volume of the Oceanographic Campaigns of Prince of Monaco by DAUTZENBERG (1889), where a large number of new species were described.

Since the foundation of the University of the Azores, several scientific expeditions were made by the Marine Biology team of the Department of Biology of this University to some of the islands ("Graciosa/88", "Flores/89", "Açores/89", "Santa Maria and Formigas/90", "Pico/91" and "Faial/93") providing new insights to the Azorean littoral knowledge in general and an improvement in the marine molluscs in particular (AZEVEDO AND MARTINS, 1989; GOFAS, 1989; AZEVEDO, 1990; GOFAS, 1990; AZEVEDO AND GOFAS, 1990; NETO AND AZEVEDO, 1990; AZEVEDO, 1991B; ÁVILA, 1996; ÁVILA AND AZEVEDO, 1996; ÁVILA, 1997; ÁVILA AND AZEVEDO, 1997; ÁVILA, 1998; ÁVILA, AZEVEDO, GONÇALVES, FONTES AND CARDIGOS, 1998; ÁVILA, AZEVEDO, GONÇALVES, FONTES AND CARDIGOS, 2000a; ÁVILA, GONÇALVES, FONTES AND CARDIGOS, 2000b; ÁVILA AND ALBERGARIA, 2002).

From 1996 on, a database with the littoral molluscs of the Azores (<50m) was constructed, based on samples collected in all the islands of the archipelago and an exhaustive and critical examination of literature was done. This data has provided the possibility to further understand the biogeographical relationships of the Azorean shallow-water marine molluscs (ÁVILA, 2000a).

Molluscs/algae biological associations were first studied in the Azores by CHAPMAN (1955), who was surprised by the great abundance of molluscs in a sample of *Corallina* sp. from Faial Island. Later, BULLOCK, TURNER AND FRALICK (1990) studied the micromolluscs associated to several monospecific algal fronds in the rocky intertidal. *Rissoa*

guernei Dautzenberg, 1889, *Tricolia pullus azorica* Dautzenberg, 1889, *Rissoella* sp. and *Omalogyra atomus* (Philippi, 1841) were found by these authors in high numbers associated to *Pterocladiella capillacea*, whereas *Ulva rigida* samples had two very common small gastropods in the intertidal, *Skeneopsis planorbis* (Fabricius O., 1780) and *Omalogyra atomus*, as well as *Tricolia pullus azorica*; on *Stypocaulon scoparia* the best represented species were *Skeneopsis planorbis*, *Rissoa guernei* and *Omalogyra atomus*.

AZEVEDO (1991a) studied the malacological communities associated to the algal fronds in the littoral of São Miguel. This author found *Pisinna glabatra* (Von Mühlfeldt, 1824) and *Omalogyra atomus* to be the most abundant species in the intertidal, whereas *Omalogyra atomus* and, occasionally, *Bittium* sp. were the most abundant taxa in the infralittoral.

At Lajes do Pico (Pico Island), in a very shallow and sheltered coastal lagoon, ÁVILA (1998) found *Cingula trifasciata* (Adams J., 1798) to be the most abundant species in the intertidal, with maximum densities of 32,500 ind./m^2. According to BULLOCK (1995), in the intertidal of the Ilhéu de Vila Franca, an islet located in the south shores of São Miguel, *Alvania mediolittoralis* Gofas, 1989 and *Crisilla postrema* (Gofas, 1990), two rissoids, can reach densities higher than 10,000 ind./m^2.

More recently, COSTA AND ÁVILA (2001) have studied the molluscs associated to monospecific samples of *Halopteris filicina* and *Stypocaulon scoparia* at São Miguel Island. The samples were collected between 11 and 15m depth and these authors found that 4 taxa (*Bittium* sp., present in all of the samples and responsible for 85.6% of the total number of molluscs collected, *Setia subvaricosa* Gofas, 1989, *Tricolia pullus azorica* and *Rissoa guernei*) made up 96.6% of the total number of molluscs.

Algae provide shelter to the molluscs, protecting them against heavy waves and currents (DEAN AND CONNEL, 1987), they work as a shelter against predators (SEED, 1986; BULLOCK ET AL., 1990) and give them food, directly through the tissues of the algae or of epiphytes diatoms or microalgae, and indirectly, through sediments and detritus that accumulate especially in the base of the algal fronds (AZEVEDO, 1991a; BULLOCK, 1995). The structural habitat complexity provided by macroalgae, usually related to higher specific richness (HICKS, 1986) is dependent upon abiotic factors such as hydrodynamic prevalent conditions, intensity and type of light and the existence of pollutants; and of biotic factors, such as predators occurrence, light competition and algal morphology, which in turn is related with the type of ramification and growth of the alga. BULLOCK ET AL. (1990) stated that algae with ramified growth, foliose or tuft-like non-coralline alga, possess a high number of micromolluscs, in contrast with species with blade-like branches (*Fucus spiralis*), filamentous algae or tuft-like coralline alga.

The main objectives of this work are to establish the zonation of the most abundant molluscs in São Miguel Island and to verify possible molluscs/algae biological associations.

MATERIALS AND METHODS

Subtidal communities off Porto das Baleias (São Vicente, Capelas) located in the north shore of São Miguel Island (Fig. 1) were surveyed under the project PRAXIS/2/2.1/BIA/169/94, "Biodiversity of the archipelago of the Azores". All samples were collected in July 1996 and July 1997 (see Table I). A transect was performed from low-tide level to 30m depth, with an extension of 450m long (Fig. 2) across a rocky bottom extensively covered by algae. *Pterocladiella capillacea*, *Ulva* spp., *Stypocaulon scoparia*, *Asparagopsis armata*, and *Hypnea musciformis* dominated the shallow levels, whereas *Plocamium cartilagineum* and *Zonaria tournefortii* were more abundant between 10 and 30m depth. *Asparagopsis armata*, *Halopteris filicina* and *Dictyota dichotoma* were present

Table I. Samplings collected at Porto das Baleias, São Vicente, Capelas (São Miguel Island). DBUA: Reference collection of the Department of Biology of the University of the Azores.
Tabla I. Muestras recogidas en Porto das Baleias, São Vicente, Capelas (Isla São Miguel). DBUA: Referencia en el Departamento de Biología de la Universidad de Azores.

	1996			1997	
Depth (m)	Date	DBUA	Depth (m)	Date	DBUA
4	19-7-96	707/G	5	16-7-97	766
4	19-7-96	707/T	5	16-7-97	785
4	19-7-96	707/C	5	16-7-97	788
5	19-7-96	708/H	6	10/7/97	784
5	19-7-96	708/I	6	10/7/97	781
5	19-7-96	708/F	6	10/7/97	782
8	18-7-96	708/C	9	15-7-97	762
8	18-7-96	703/E	9	15-7-97	772
8	18-7-96	703/B	9	15-7-97	764
12	18-7-96	703/H	10	15-7-97	777
12	18-7-96	704/A	10	15-7-97	769+791
12	18-7-96	704/D	10	15-7-97	771
14	17-7-96	701/B	12	14-7-97	768
14	17-7-96	701/A	12	14-7-97	778
14	17-7-96	701/C	12	14-7-97	776
16	17-7-96	702/D	15	11/7/97	783
16	17-7-96	702/E	15	11/7/97	779
16	17-7-96	702/H	15	11/7/97	787
22	16-7-96	694/D	20	11/7/97	780+790
22	16-7-96	692/B	20	11/7/97	767
22	16-7-96	693/C	20	11/7/97	786
27	15-7-96	690/B	25	12/7/97	763+773
27	15-7-96	691/C	25	12/7/97	774
27	15-7-96	689/A	25	12/7/97	789
			30	14-7-97	770
			30	14-7-97	775
			30	14-7-97	765

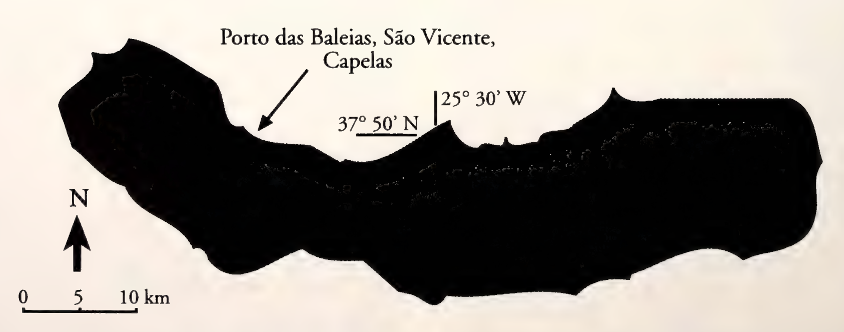
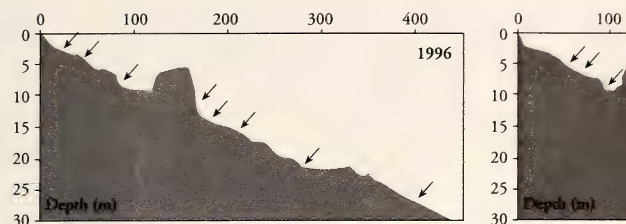


Figure 1. São Miguel Island (Azores), with the location of Porto das Baleias, São Vicente, Capelas.
Figura 1. Isla São Miguel (Azores), con la localización de Porto das Baleias, São Vicente, Capelas.



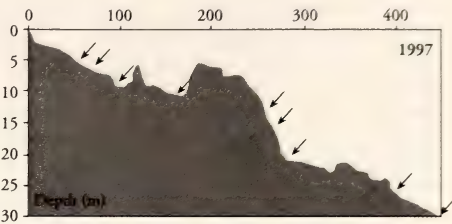


Figure 2. Profile of the transects, Porto das Baleias, São Vicente, Capelas (São Miguel, Azores) in 1996 and 1997. The arrows show the sampling sites of the 3 replicates.
Figura 2. Perfil de los transectos, Porto das Baleias, São Vicente, Capelas (São Miguel, Azores) en 1996 y 1997. Las flechas muestran los lugares de muestra de las 3 réplicas.

along all transect. In most of the transect, large boulders were dominant, but especially bellow 20m depth, there were large areas of bedrock interspersed with sandy patches.

Minimum area for quantitative studies of algae in the Azorean sublittoral is 50x50cm (NETO, 1997) larger than the minimum area determined for molluscs (25x25cm) (AZEVEDO, 1991a) so the former area was used. Three quadrates were scrapped in each selected depth; the algae collected were put in a labeled cotton drawstring bag. In the laboratory, samples were washed several times with seawater and animals were removed by pouring the washing water through 1 mm, 0.5 mm and 0.25 mm mesh sieves. Samples were labeled and preserved in 70% ethanol. After draining for about 30min, the wet weight of the algae was determined

Table II. Most common taxa/species found at Porto das Baleias, São Vicente, Capelas during the 1996 and 1997 campaigns. n: total number of specimens collected.
Tabla II. Especies más comunes en Porto das Baleias, São Vicente, Capelas durante las campañas de 1996 y 1997. n: número total de especímenes recolectados.

	1996 n	1997 n	1996 %	1997 %
Bittium sp.	11,936	12,374	61.1	75.4
Tricolia pullus azorica	2,737	993	14.0	6.1
Parvicardium vroomi	557	1042	2.9	6.4
Jujubinus pseudogravinae	753	216	3.9	1.3
Manzonia unifasciata	719	78	3.7	0.5
Alvania sleursi	526	284	2.7	1.7
Crassadoma pusio	442	36	2.3	0.2
Cardita calyculata	320	117	1.6	0.7
Alvania angioyi	205	159	1.1	1.0
Ocinebrina aciculata	145	162	0.7	1.0
Anachis avaroides	168	108	0.9	0.7
Gibbula delgadensis	62	160	0.3	1.0
Rissoa guernei	155	35	0.8	0.2
Total	18,725	15,764	96.0	96.2
TOTAL (all taxa)	19,540	16,420	100.0	100.0

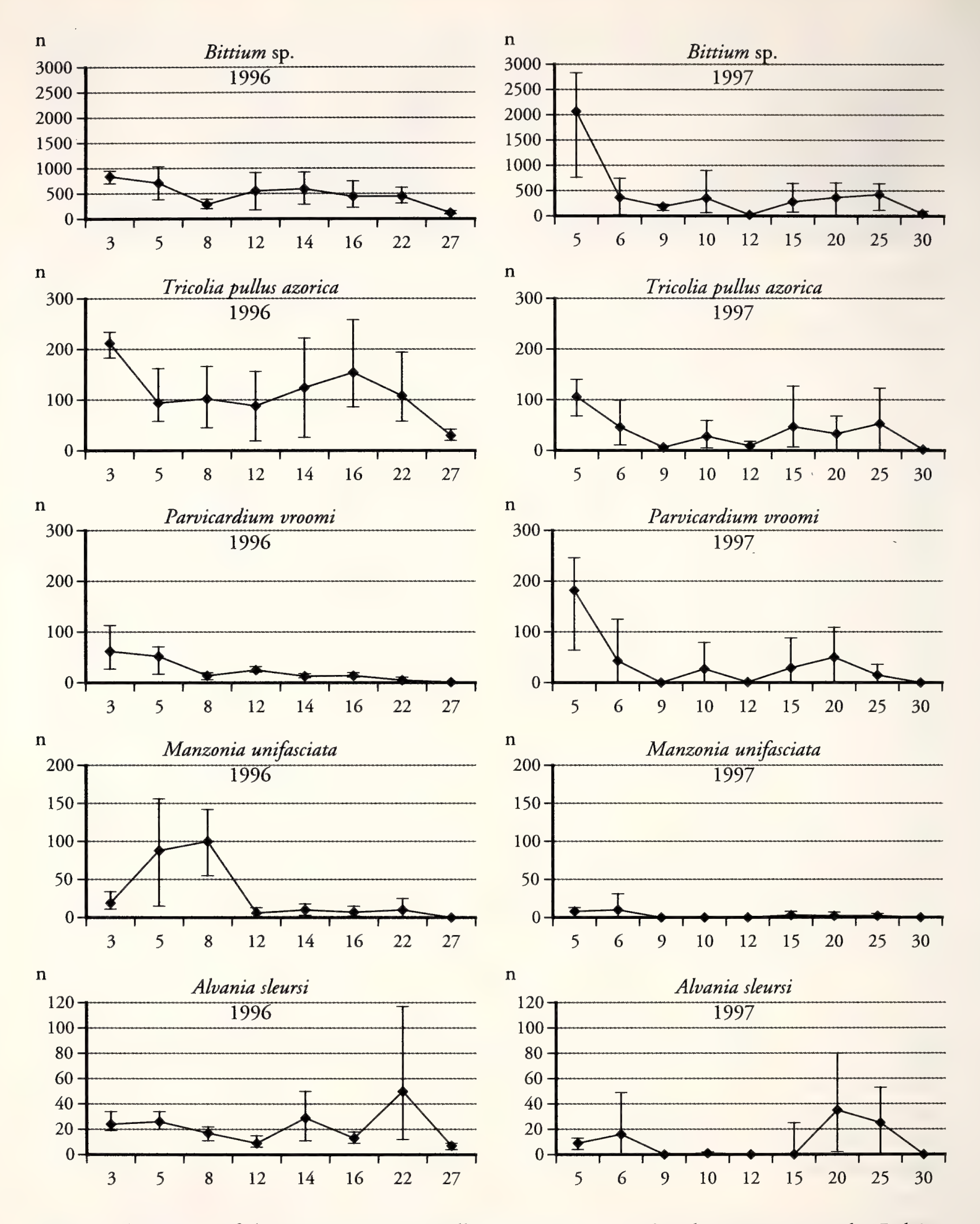


Figure 3. Zonation of the most common molluscs species in 1996 and 1997 at Porto das Baleias, São Vicente, Capelas (São Miguel, Azores) (maximum, mean and lower values by depth).
Figura 3. Zonación de las especies de moluscos más comunes en 1996 y 1997 en Porto das Baleias, São Vicente, Capelas (São Miguel, Azores) (valores máximo, medio y mínimo por profundidad).

(±0,01g). All molluscs found in the 1 mm mesh sieve were sorted, identified and counted (see Appendices 1 and 2). Only live molluscs were counted. Molluscs retained in the 0.5 mm and 0.25 mm mesh sieves will be studied in future works. About 300 days were spent just sorting the material. All

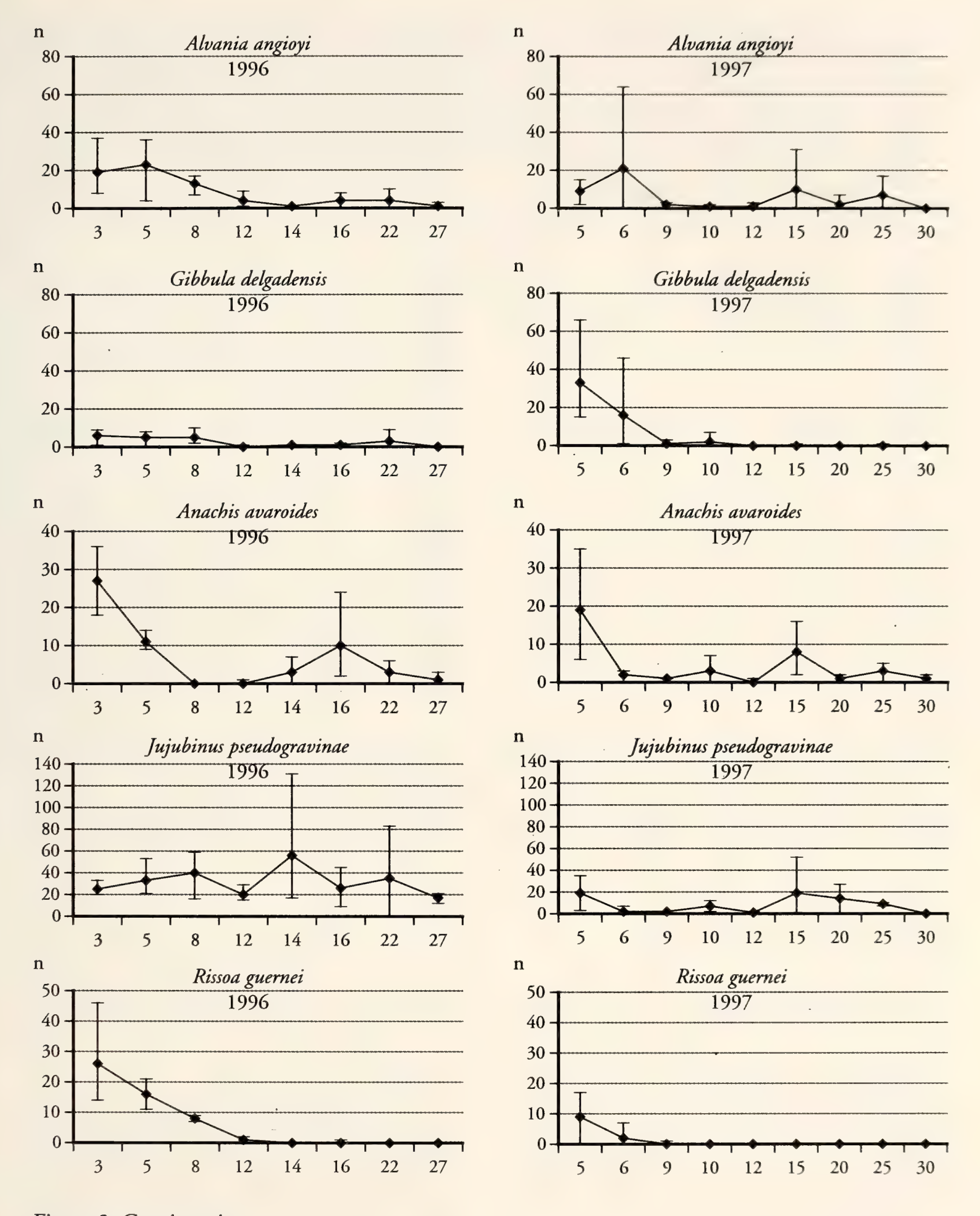


Figure 3. Continuation.
Figura 3. Continuación.

samples were given a number and were deposited in the DBUA (Department of Biology of the University of the Azores) marine molluscs reference collection.

Most problematic molluscan taxa were photographed under the scanning electronic microscope (protoconch, teleoconch, and microsculpture of both); these photos were quite useful in the posterior identification. Algae were identified by Dra. Ana Neto (University of the Azores).

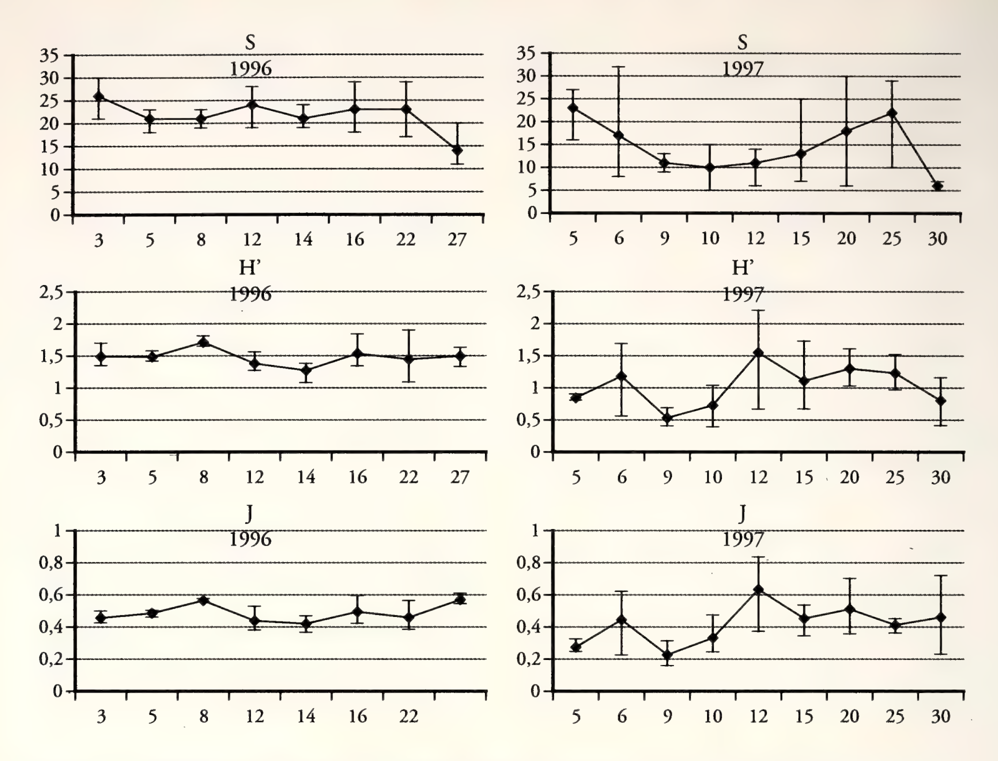


Figure 4. Taxa/species number (S), diversity index of Shannon-Wiener (H') and equitatibility index (J) by depth in 1996 and 1997 (maximum, mean and lower values by depth).
Figura 4. Número de especies (S), índice de diversidad de Shannon-Wiener (H') e índice de equitatibilidad (J) por profundidades en 1996 y 1997 (valores máximo, medio y mínimo por profundidad).

STATISTICAL ANALYSIS

Data were analyzed with the statistical package PRIMER (version 5.2) (Plymouth Routines in Multivariate Ecological Research - Plymouth Marine Laboratory). For each depth sampled in both campaigns (1996 and 1997), zonation graphs were constructed for the most abundant taxa with maximum, mean and lower density values.

Species diversity was calculated in each quadrate, using species richness (S) and diversity indices of Shannon-Wiener (H') and evenness (J) (KREBS, 1989; BEGON, HARPER AND TOWNSEND, 1996).

Multivariate analysis was performed, with raw data transformed by $\sqrt{\sqrt{(x)}}$ (FIELD, CLARKE AND WARWICK, 1982; CLARKE AND AINSWORTH, 1993). In Q-analysis, dendrograms were constructed with Bray-Curtis similarity index followed by UPGMA method (FIELD *ET AL*., 1982); R-analysis was also performed, dendrograms constructed by using Euclidean distance and UPGMA method.

ANOSIM/PRIMER program ("randomization/permutation test") (WARWICK AND CLARKE, 1993) was used with 20,000 permutations, to test differences between pre-selected groups of samples. This program results in a value of R, between –1 and +1 (usually, R> 0). If R= 1, this means that all replicates of a given depth are more similar than any replicates of different depths; if R≈ 0, the similarity between replicates is independent of its depth and will be similar, in average (CLARKE AND WARWICK, 1994).

Species with a ratio>1.40 (SIMPER/PRIMER analysis) were considered as

Table III. Diversity indices by quadrate in 1996 and 1997. S: number of taxa/species; H': diversity index of Shannon-Wiener; J: index of equitatibility.
Tabla III. Índices de diversidad por cuadrado en 1996 y 1997. S: número de especies; H': índice de diversidad de Shannon-Wiener; J: índice de equitabilidad.

		1996					1997		
Quadrate	Depth	S	H'	J	Quadrate	Depth	S	H'	J
1	3	28	1.42	0.426	1	5	16	0.90	0.326
2	3	21	1.35	0.443	2	5	27	0.82	0.248
3	3	30	1.70	0.500	3	5	26	0.81	0.248
4	5	23	1.58	0.504	4	6	32	1.69	0.486
5	5	23	1.45	0.462	5	6	12	0.56	0.226
6	5	18	1.42	0.491	6	6	8	1.29	0.622
7	8	20	1.67	0.556	7	9	9	0.69	0.314
8	8	23	1.81	0.577	8	9	11	0.50	0.207
9	8	19	1.65	0.560	9	9	13	0.41	0.159
10	12	19	1.56	0.529	10	10	15	0.75	0.276
11	12	25	1.30	0.405	11	10	5	0.39	0.245
12	12	28	1.27	0.3861	12	10	9	1.04	0.475
13	14	24	1.35	0.424	13	12	14	2.21	0.837
14	14	19	1.38	0.470	14	12	6	0.67	0.373
15	14	19	1.08	0.367	15	12	13	1.77	0.691
16	16	29	1.42	0.423	16	15	7	0.67	0.345
17	16	18	1.34	0.465	17	15	7	0.93	0.476
18	16	22	1.84	0.595	18	15	25	1.73	0.537
19	22	23	1.34	0.427	19	20	18	1.03	0.357
20	22	17	1.09	0.385	20	20	30	1.61	0.473
21	22	29	1.90	0.565	21	20	6	1.26	0.703
22	27	11	1.33	0.555	22	25	27	1.20	0.363
23	27	12	1.52	0.610	23	25	10	0.97	0.422
24	27	20	1.63	0.545	24	25	29	1.52	0.452
					25	30	7	0.83	0.429
					26	30	5	1.16	0.721
					27	30	6	0.41	0.231

mainly responsible for the differences detected between pre-selected groups (WARWICK, PLATT, CLARKE, AGARD AND GOBIN, 1990). Three groups were selected, based on the empirical knowledge of the transect's bottom characteristics: shallow levels (until 10m depth), medium depths (between 10 and 20m depth) and deeper levels (from 20 down to 30m depth). These pre-selected groups were designed by the letters s ("shallow"), m ("medium") and d ("deep"), respectively.

DAFOR scale, [D-dominant (>75%); A-abundant (50%); F-frequent (25%); O-occasional (10%); R-rare (5%)] was used to measure the relative abundance of the algae species. As this is a semi-quantitative scale, in contrast to the quantitative molluscs data, the latter were transformed accordingly, in order to test possible molluscs/algae biological associations. A multivariate analysis was conducted over the semi-quantitative molluscs-algae data (most abundant species in both 1996 and 1997) and dendrograms were constructed using Bray-Curtis similarity index followed by UPGMA. Euclidean distance was used to construct the dendrograms of the analysis of pooled semi-quantitative molluscs-algae data.

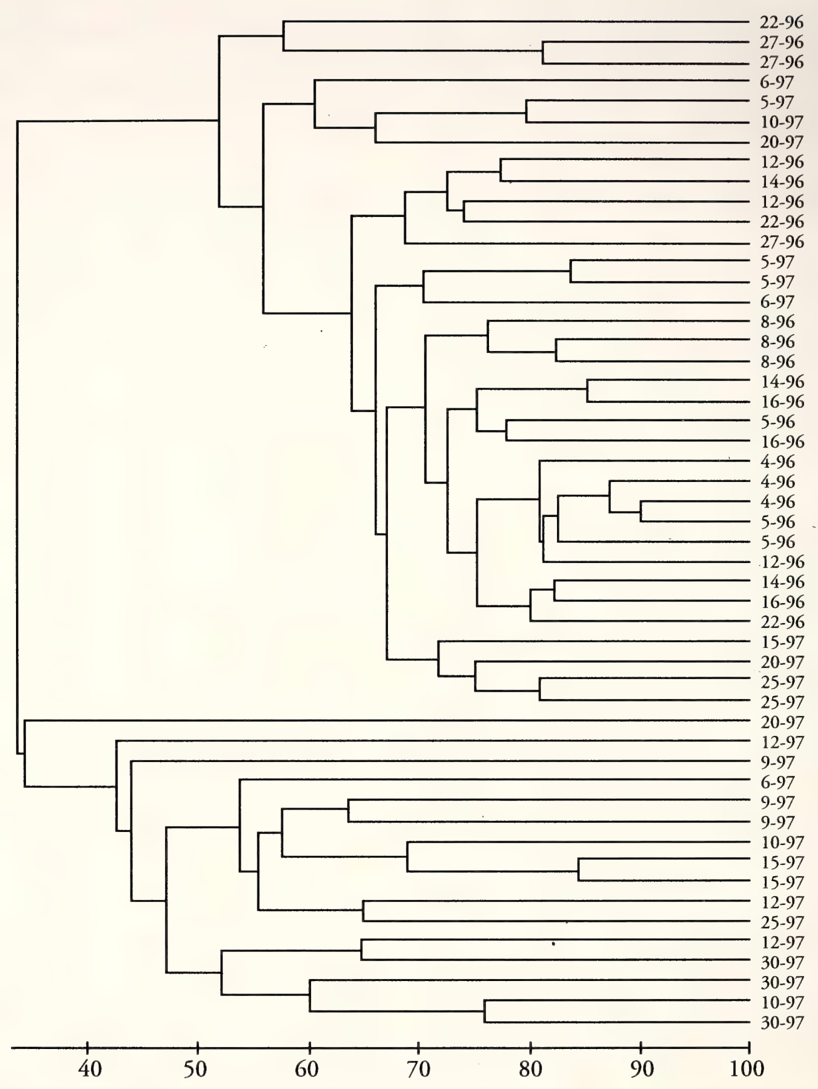


Figure 5. All replicates of 1996 and 1997 grouped by depth-year. Data transformed by √√x, Bray-Curtis similarity index, UPGMA.

Figura 5. Total de réplicas de 1996 y 1997 agrupadas por profundidad-año. Datos transformados por √√x, índice de similaridad de Bray-Curtis, UPGMA.

RESULTS

A total of 35,960 specimens were counted in both 1996 and 1997 campaigns at São Vicente, Capelas, belonging to 71 taxa (56 Gastropoda, 13 Bivalvia and 2 Polyplacophora). Of those, 19,540 specimens were collected in 1996 and 16,420 in 1997. Forty-one taxa were found in both years (see Appendices 1 and 2), 11 and 17 taxa exclusively in 1996 and 1997, respectively.

Bittium sp. was the commonest taxa, with 11,936 and 12,374 individuals (61.1% and 75.4%, respectively in 1996 and 1997). Thirteen taxa accounted for

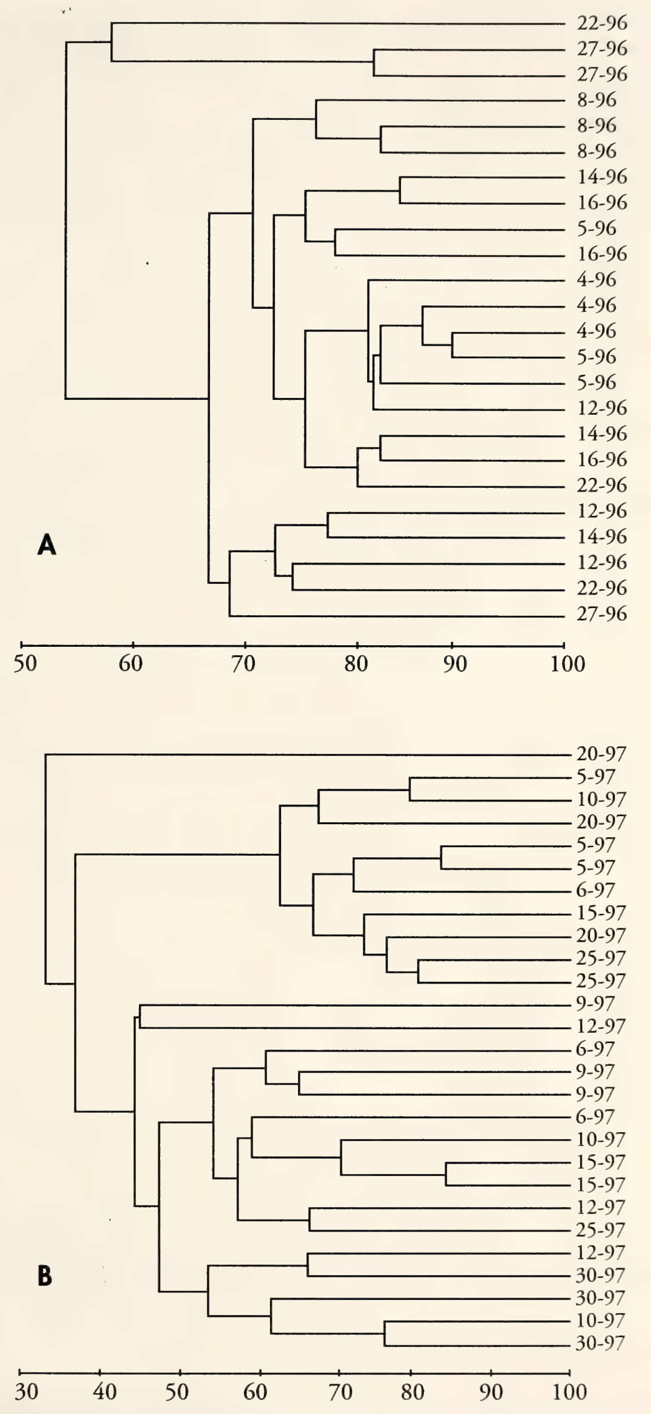
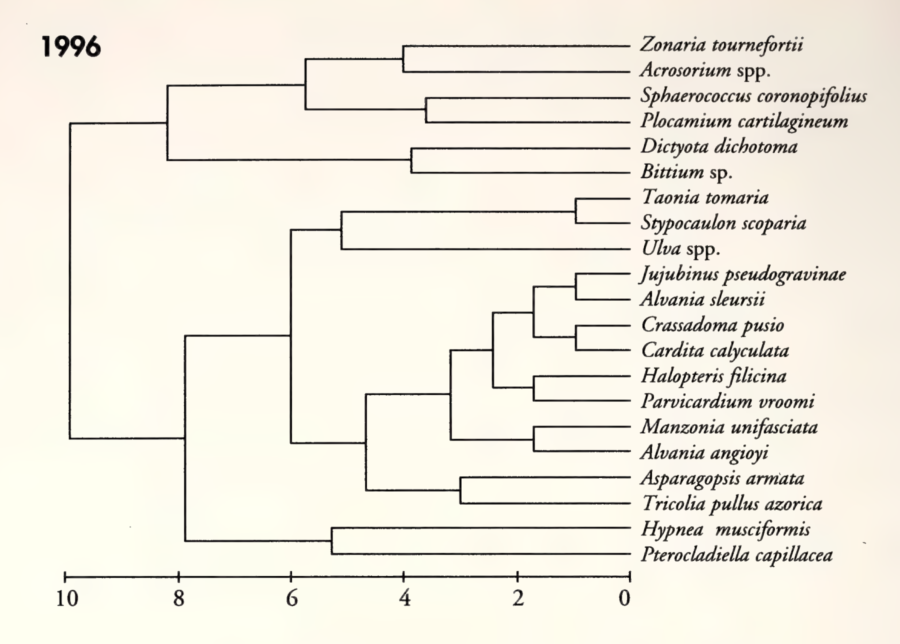


Figure 6. A: replicates of 1996; B: replicates of 1997 (grouped by depth-year). Data transformed by $\sqrt{\sqrt{x}}$, Bray-Curtis similarity index, UPGMA.

Figura 6. A: réplicas de 1996; B: réplicas de 1997 (agrupadas por profundidad-año). Datos transformados por $\sqrt{\sqrt{x}}$, índice de similaridad de Bray-Curtis, UPGMA.



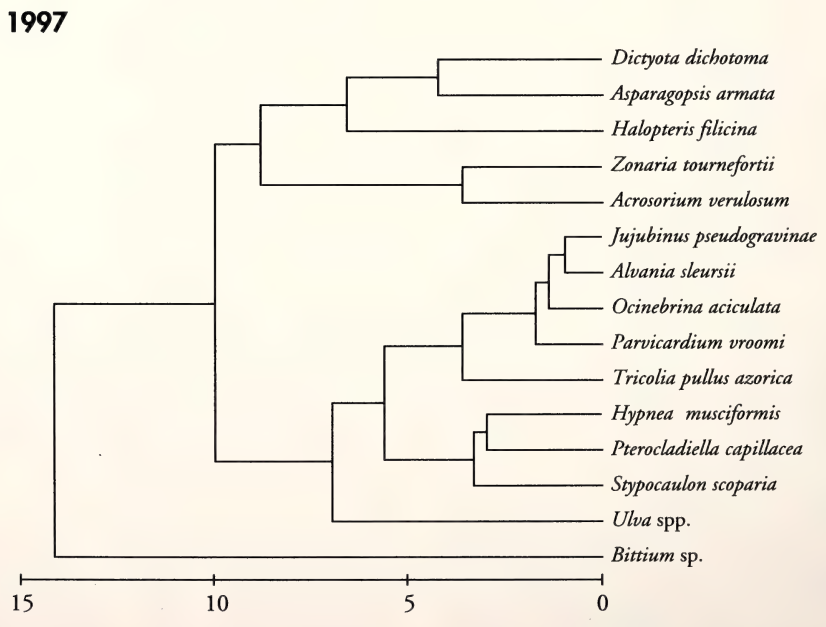


Figure 7. Mollusc/algae collected in 1996 and 1997. Non-transformed semi-quantitative data, DAFOR scale. Euclidean distance, UPGMA.

Figura 7. Moluscos/algas recolectados en 1996 y 1997. Datos semicuantitativos no transformados, escala DAFOR. Distancias euclidianas, UPGMA.

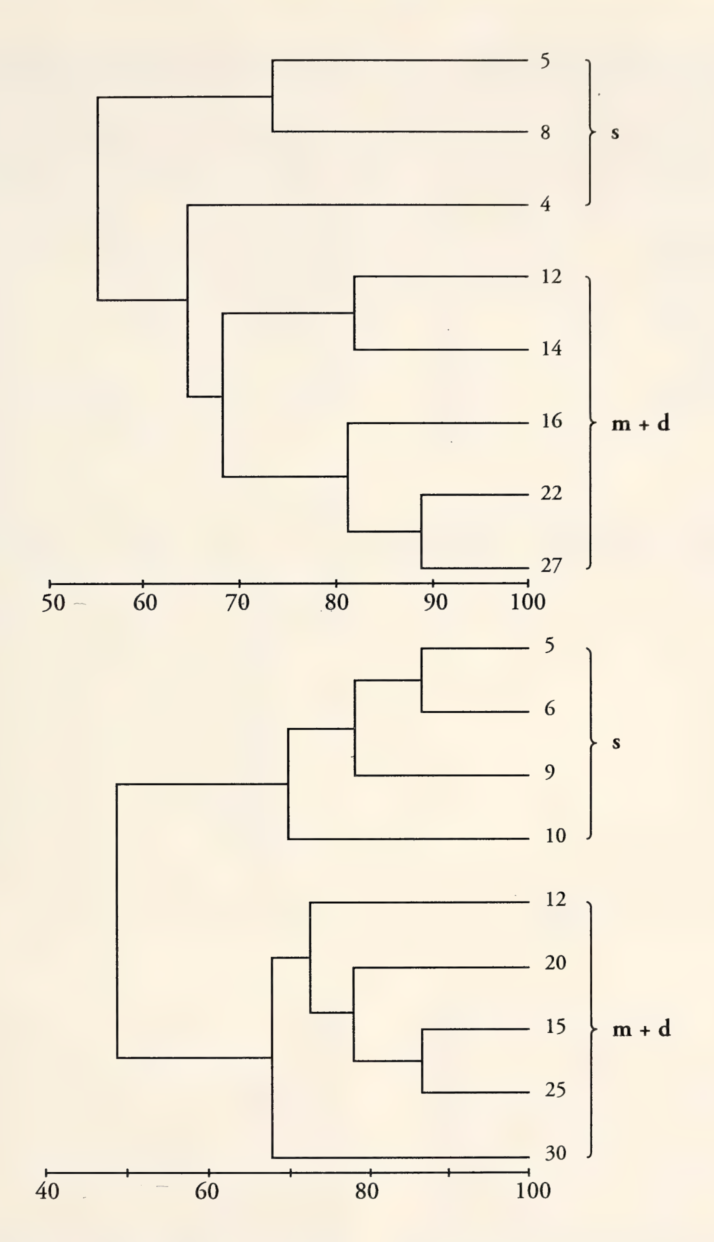


Figure 8. Molluscs/algae collected in 1996 and 1997. Non-transformed semi-quantitative data, DAFOR scale. Bray-Curtis similarity index, UPGMA.
Figura 8. Moluscos/algas recolectados en 1996 y 1997. Datos semicuantitativos no tarnsformados, escala DAFOR. Índice de similaridad de Bray-Curtis, UPGMA.

about 96% of the total of specimens collected in both campaigns (see Table II). Some differences in the relative abundance of the commonest taxa were found between the two years. Besides *Bittium* sp., most abundant taxa in 1996 were *Tricolia pullus azorica* (14,0%), *Jujubinus pseudogravinae* Nordsieck, 1973

Table IV. Pre-defined groups and symbols used in the multivariate analysis with ANOSIM and SIMPER programs.
Tabla IV. Grupos predefinidos y símbolos usados en el análisis multivariantes con los programas ANOSIM y SIMPER.

Pre-defined groups	Depth (m) - year
s96 – shallow water, 1996	4-96; 5-96; 8-96
s97 – shallow water, 1997	5-97; 6-97; 9-97; 10-97
m96 – medium water, 1996	12-96; 14-96; 16-96
m97 – medium water, 1997	12-97; 15-97; 20-97
d96 – deep water, 1996	22-96; 27-96
d97 – deep water, 1997	25-97; 30-97

Table V. ANOSIM results. Data transformed by $\sqrt{\sqrt{x}}$. Other symbols as in Table IV.
Tabla V. Resultados de ANOSIM. Datos transformados por $\sqrt{\sqrt{x}}$. Resto de símbolos como en la Tabla IV.

Comparisons between groups	R
s96 / s97	0.277
m96 / m97	0.430
d96 / d97	0.431
s97 / m97	0.039
m97 / d97	-0.031
d96 / m97	0.137
(s96-s97) / (m96-m97)	0.056
(s96-s97) / (d96-d97)	0.198
(m96-m97) / (d96-d97)	0.046
(s96-m96-d96) / (s97-m97-d97)	0.337

and *Manzonia unifasciata* (Dautzenberg, 1889), both with 4%, and *Parvicardium vroomi* van Aartsen, Menkhorst and Gittenberger, 1984, *Alvania sleursi* (Amati, 1987) and *Crassadoma pusio* (Linnaeus, 1758), all between 2-3%. In 1997, *P. vroomi* and *T. pullus azorica* (6,4% and 6,1%) were the most abundant species after *Bittium* sp., followed by *Alvania sleursi* and *Jujubinus pseudogravinae* with a little more than 1% of the total number of molluscs collected in that year. *Bittium* sp. was found in all quadrates sampled in 1996 and 1997, whereas *A. sleursi, C. pusio* and *T. pullus azorica* were present in all quadrates in 1996 (Appendices 1 and 2).

Some species were clearly only abundant in shallow levels (down to 5-6m) as the endemic rissoids *Alvania angioyi* van Aartsen, 1982, *Manzonia unifasciata* and *Rissoa guernei*, the also endemic trochid *Gibbula delgadensis* Nordsieck, 1982, the Macaronesian *Anachis avaroides* Nordsieck, 1975 and the small bivalve *Parvicardium vroomi*. On the other side, the endemic rissoid *Alvania sleursi*, is especially abundant below 20m depth, whereas *Bittium* sp., *Tricolia pullus azorica* and *Jujubinus pseudogravinae* were found along all transect. The highest variation detected when both years are compared, is related to the higher abundance of *Bittium* sp. at 5m in 1997 (Fig. 3).

Species number and diversity indices of Shannon-Wiener (H′) and evenness (J), show lower variations between replicates by depth in 1996 when compared to 1997 (cf. Table III and Fig. 4).

When all 1996 and 1997 replicates are pooled, the dendrogram (Q-analysis) shows a clear split of replicates by year (Fig. 5). Besides, and with only a few exceptions, most of the clusters are among replicates of similar depths. A similar analysis by year shows that in 1996, replicates follow the depth gradient (Fig. 6A); in contrast, 1997 replicates do not show such an evident pattern, with higher mixture of replicates of different depths/levels (cf. Fig. 6B).

Cluster analysis of pooled algae-molluscs data (Euclidean distance) is not particularly elucidative. In the 1996 campaign (Fig. 7), *Bittium* sp. clusters with the alga *Dictyota dichotoma*, *Parvicardium vroomi* clusters with *Halopteris filicina* and *Tricolia pullus azorica* clusters with *Asparagopsis armata*. In the 1997 campaign, a strong dichotomy between molluscs and algae was found, no molluscs being associated to any alga species. If the same procedure (cluster analysis of pooled algae-molluscs data) is repeated, now in R-mode, there is a clear separation between shallow levels (s) and medium-deep depths (Fig. 8).

Major differences among predefined groups (see Table IV) do occur between medium depth replicates of 1996 and 1997 (m96/m97), between the deepest levels of 1996 and 1997 (d96/d97) and between all samples of 1996 and 1997 (s96-m96-d96 / s97-m97-d97) (see Table V).

Average similarity values of predefined groups (s, m, d) is higher in 1996 than in 1997, *Bittium* sp. and *Tricolia pullus azorica* being responsible for this. Average similarity decreases with depth, when the same level is compared in the two years (s96/s97, m96/m97 and d96/d97). Similarities among shallow and medium depth levels are best explained by the two previous taxa plus *Jujubinus pseudogravinae*. In the deepest levels (d96/d97), we must add the muricid *Ocinebrina aciculata* (Lamarck, 1822) to *Bittium* sp. and *Tricolia pullus azorica* (cf. Table VI).

Crassadoma pusio and *Alvania sleursi* are responsible for most of the differences detected between levels (s96/s97, m96/m97 e d96/d97), their importance increasing with depth. Actually, total number of *Crassadoma pusio* individuals in 1997 is less than 10% the number in 1996; *Alvania sleursi* specimens in 1997 are about half total numbers in 1996. In 1996, *Rissoa guernei* and *Alvania angioyi*, both common species in the shallow levels, distinguish these levels from the medium and deep ones, *Parvicardium vroomi*, uncommon from 20m on, explaining the medium-deep level differences together with *Bittium* sp. In 1997, *Bittium* sp. and *Tricolia pullus azorica* splits medium from deep levels. When all levels are pooled by year (s96-m96-d96 / s97-m97-d97), *Alvania cancellata*, *Alvania sleursi*, *Crassadoma pusio* and *Manzonia unifasciata* (more abundant in 1996), and *Bittium* sp. and *Parvicardium vroomi* (more abundant in 1997) are responsible for the differences detected (Table VII).

DISCUSSION

No specific molluscs/algae associations were found in this work, however, a certain algal preference was detected because of the high densities of a few molluscan taxa in some algae. The most obvious examples were *Bittium* sp. in *Halopteris filicina* and *Pterocladiella capillacea*, *Parvicardium vroomi* in *Halopteris filicina*, and *Tricolia pullus azorica* in *Asparagopsis armata*, *P. capillacea* and *Dictyota dichotoma*. It appears that the algae provide a good microhabitat for the molluscs, rather than being their main source of food. It is interesting to note the common presence of *Tricolia pullus azorica* in *Asparagopsis armata*, a red algae that is usually devoid of molluscs. This algae was introduced into the Atlantic and Mediterranean in the beginning of the 20th century (Feldmann and Feldmann, 1942) and is now widely distributed in the north-eastern Atlantic, from the Bristish isles south to Senegal, the Azores, Madeira and Canary Islands (Dixon, 1964).

Table VI. SIMPER results. Data transformed by √√x. Aan: *Alvania angioyi*; Aca: *Alvania cancellata*; Asl: *Alvania sleursi*; Ana: *Anachis avaroides*; Bit: *Bittium* sp.; Car: *Cardita calyculata*; Cra: *Crassadoma pusio*; Gib: *Gibbula delgadensis*; Juj: *Jujubinus pseudogravinae*; Man: *Manzonia unifasciata*; Mar: *Marshallora adversa*; Nas: *Nassarius incrassatus*; Oci: *Ocinebrina aciculata*; Par: *Parvicardium vroomi*; Ris: *Rissoa guernei*; Tri: *Trichomusculus semigranatus*; Tpa: *Tricolia pullus azorica*. Other symbols as in Table IV.

Groups	Average similarity	Taxa/Species
s96	76.29	Bit – Tpa – Man – Juj – Par – Asl – Ris – Aan
m96	72.58	Bit – Tpa – Juj – Par – Cra – Asl – Car
d96	45.71	Bit – Tpa – Asl – Cra - Oci
s97	47.33	Bit - Tpa
m97	42.28	Bit
d97	45.71	Bit – Tpa - Mar
s96 / s97	53.10	Bit – Tpa – Juj - Nas
m96 / m97	50.10	Bit – Tpa -Juj - Nas
d96 / d97	45.83	Bit – Tpa - Oci
(s96-m96-d96)	67.13	Bit – Tpa – Juj – Asl – Cra – Par – Car – Man – Oci – Aca - Nas
(s97-m97-d97)	43.88	Bit - Tpa

BULLOCK *ET AL*. (1990) did not find also any specific biological associations of molluscs to algae in São Miguel Island. According to these authors, the majority of the molluscs found in their samples were common in several species of algae (e.g.: *Omalogyra atomus*, very common in *Pterocladiella capillacea* and *Stypocaulon scoparia*, *Gibbula magus* (Linnaeus, 1758) in *Padina pavonica* and *Stypocaulon scoparia*, and the small bivalve *Lasaea adansoni* (Gmelin, 1791) in *Sargassum vulgare* and *Gelidium spinulosum*). COSTA AND ÁVILA (2001) found *Bittium* sp. with high-density values in monospecific samples of *Stypocaulon scoparia* and of *Halopteris filicina*; with lower densities, *Setia subvaricosa*, *Tricolia pullus azorica* and *Rissoa guernei* were also common molluscs.

The differences detected in the relative abundances of the malacological communities associated to algae, are usually related to different habitat conditions, both biotic (species and type of most common algae, algal biomass, predation intensity) as abiotic conditions (especially the hydrodynamics and the total amount of sediment that algal fronds may trap and hold) (AZEVEDO, 1991a).

Feeding habits may influence mollusc's distribution by depth. *Bittium* sp. and *Tricolia pullus azorica*, the two most abundant taxa, were found along the entire transect. Such distribution may be attributed to their detritivorous

Tabla VI. Resultados de SIMPER. Datos transformados con by $\sqrt{\sqrt{x}}$. Aan: Alvania angioyi*; Aca:* Alvania cancellata*; Asl:* Alvania sleursi*; Ana:* Anachis avaroides*; Bit:* Bittium *sp.; Car:* Cardita calyculata*; Cra:* Crassadoma pusio*; Gib:* Gibbula delgadensis*; Juj:* Jujubinus pseudogravinae*; Man:* Manzonia unifasciata*; Mar:* Marshallora adversa*; Nas:* Nassarius incrassatus*; Oci:* Ocinebrina aciculata*; Par:* Parvicardium vroomi*; Ris:* Rissoa guernei*; Tri:* Trichomusculus semigranatus*; Tpa:* Tricolia pullus azorica. *Resto de símbolos como en la Tabla IV.*

Taxa/Species (%) (Ratio of each taxa/species)	Cumulative %
13.59 – 9.57 – 7.21 – 6.91 – 6.52 – 6.49 – 5. 68 – 5.51 (10.00 – 6.49 – 3. 77 – 7.71 – 8.01 – 8.86 – 10.24 – 7.97)	61.85
15.50 – 10.11 – 7.33 – 6.95 – 6.88 – 6.45 – 6.42 (9.22 – 6.31 – 8.48 – 6.42 – 7.31 – 7.70 – 5.25)	59.64
19.69 – 13.75 – 9.58 – 9.49 – 6.75 (4.94 – 4.13 – 4.51 – 3.30 – 5.08)	59.26
33.11 – 17.53 (2.79 – 2.58)	50.64
31.72 (2.30)	31.72
32.87 – 15.84 – 15.46 (2.05 – 1.92 – 1.66)	64.17
24.32 – 13.82 – 7.50 –5.34 (3.18 – 3.32 – 1.72 – 1.59)	50.98
22.71 – 11.35 – 7.82 – 6.33 (3.16 – 1.72 – 1.73 – 1.42)	48.11
28.64 – 15.45 – 8.91 (2.70 – 2.90 – 1.54)	53.00
16.44 – 11.12 – 7.69 – 7.45 – 6.96 – 5.20 – 4.88 – 4.54 – 4.04 – 3.51 – 3.22 (7.74 – 5.97 – 2.81 – 5.98 – 4.26 – 1.66 – 1.69 – 1.54 – 2.03 – 1.59 – 1.67)	75.04
33.88 – 15.39 (2.36 – 1.68)	49.27

habits, although *Tricolia* is thought to feed also on alga tissues and diatoms (FRETTER AND GRAHAM, 1977; BORJA, 1986; GRAHAM, 1988). Shallow-water rissoids (*Alvania angioyi*, *A. mediolittoralis*, *Manzonia unifasciata* and *Rissoa guernei*) as well as deep-water (*Alvania cancellata* (da Costa, 1778) and *A. sleursi*) also feed preferably on diatoms and epiphyte microalgae, as well as on the food trapped by the sediment that accumulates in the base and in the interstices of the branches of algal fronds (FRETTER AND GRAHAM, 1981; GRAHAM, 1988; ÁVILA, 2000b). *Anachis avaroides* and *Nassarius incrassatus* (Ström, 1768) are carnivorous or scavengers (*N. incrassatus*) feeding on small invertebrates, molluscs included. *Marshallora adversa* (Montagu, 1803) probably feeds on sponges (GRAHAM, 1988) and all bivalves herein are suspension feeders.

The methodology followed in this work was effective in the establishment of the zonation of the most common taxa of molluscs, but did not properly answered to the question of the molluscs/alga biological associations. This is only possible with a broadly systematic study of monospecific algae samples (see BULLOCK *ET AL.*, 1990; COSTA AND ÁVILA, 2001).

The time of sampling is also a non-negligible factor. AZEVEDO (1991a) studied the infralittoral communities of molluscs along a period of one year in

Table VII. SIMPER results. Data transformed by $\sqrt{\sqrt{x}}$. Aan: *Alvania angioyi*; Aca: *Alvania cancellata*; Asl: *Alvania sleursi*; Ana: *Anachis avaroides*; Bit: *Bittium* sp.; Car: *Cardita calyculata*; Cra: *Crassadoma pusio*; Gib: *Gibbula delgadensis*; Juj: *Jujubinus pseudogravinae*; Man: *Manzonia unifasciata*; Mar: *Marshallora adversa*; Nas: *Nassarius incrassatus*; Oci: *Ocinebrina aciculata*; Par: *Parvicardium vroomi*; Ris: *Rissoa guernei*; Tri: *Trichomusculus semigranatus*; Tpa: *Tricolia pullus azorica*. Other symbols as in Table IV.

Groups	Average dissimilarity	Taxa/species
s96 / s97	51.10	Man – Par – Ris – Asl -Cra
m96 / m97	56.41	Bit – Par – Cra - Asl
d96 / d97	60.00	Cra – Asl - Tpa
s96 / m96	29.18	Ris – Ana – Aan - Gib
m96 / d96	37.36	Par - Bit
s96 / d96	41.65	Ris – Man – Par - Aan
s97 – m97	52.82	Cra – Par – Bit – Mar – Man – Tri - Aca
m97 / d97	56.28	Bit - Tpa
s97 / d97	58.67	-
(s96-s97) / (m96-m97)	49.92	-
(s96-s97) / (d96-d97)	55.15	-
(m96-m97) / (d96-d97)	52.66	-
(s96-m96-d96) / (s97-m97-d97)	56.22	Cra – Asl – Man – Bit – Par - Aca

two localities of São Miguel Island (Ribeirinha, located in the north and Caloura, in the south shore). During this time, he found that the molluscs' density was higher in the beginning of the summer, decreasing then and reaching its lower values during the winter times. At Ribeirinha, the most abundant species (>1 mm) were *Bittium* sp. *Tricolia pullus azorica*, *Jujubinus pseudogravinae*, *Nassarius incrassatus*, *Parvicardium vroomi*, *Anachis avaroides* and *Ocinebrina aciculata* (Azevedo, 1991b).

In this study, with the sole exception of *N. incrassatus*, all other taxa were also the commonest at São Vicente (Capelas) in 1996 and in 1997. These results point to a remarkable stability in species composition as well as in mean abundance values of the malacological communities associated to macroalgae in the rocky shores of the Azores archipelago, however, *Tricolia pullus azorica*, *Jujubinus pseudogravinae*, *Manzonia unifasciata* and *Crassadoma pusio* were 2 to 4 times more abundant in July 1996 than in 1997, and *Parvicardium vroomi* was commonest in 1997. Some of the species found only in one of the years are accidental (e.g.: *Melarhaphe neritoides*, *Pisinna glabatra*, *Pedipes pedipes* and *Lasaea adansoni*) which belong to the supralittoral, and others are just rare or encountered by chance, as is the case of the not identi-

Tabla VII. Resultados de SIMPER. Datos transformados con by $\sqrt{\sqrt{x}}$. *Aan:* Alvania angioyi; *Aca:* Alvania cancellata; *Asl:* Alvania sleursi; *Ana:* Anachis avaroides; *Bit:* Bittium *sp.*; *Car:* Cardita calyculata; *Cra:* Crassadoma pusio; *Gib:* Gibbula delgadensis; *Juj:* Jujubinus pseudogravinae; *Man:* Manzonia unifasciata; *Mar:* Marshallora adversa; *Nas:* Nassarius incrassatus; *Oci:* Ocinebrina aciculata; *Par:* Parvicardium vroomi; *Ris:* Rissoa guernei; *Tri:* Trichomusculus semigranatus; *Tpa:* Tricolia pullus azorica. *Resto de símbolos como en la Tabla IV.*

Taxa/species (%) Ratio of each taxa/species)	Cumulative %
7.32 – 5.25 – 4.85 – 4.83 – 4.51 (1.76 – 1.70 – 1.74 – 1.50 – 2.06)	26.76
5.63 – 5.05 – 4.94 – 4.64 (1.52 – 1.69 – 1.62 – 1.53)	25.57
6.47 – 6.24 – 4.71 (1.46 – 1.72 – 1.66)	17.41
7.57 – 4.64 – 4.40 – 4.32 (3.06 – 1.40 – 1.43 – 1.55)	20.93
5.68 – 4.16 (1.47 – 1.42)	9.84
6.68 – 6.43 – 6.01 – 4.77 (5.97 – 1.54 – 1.76 – 1.58)	26.96
5.53 – 5.02 – 4.38 – 4.10 – 4.07 – 3.88 – 3.55 (2.26 – 2.06 – 1.50 – 1.73 – 1.68 – 1.81 – 2.28)	30.53
6.06 – 5.73 (1.57 – 1.49)	11.79
no taxa/species with ratio > 1.40	-
no taxa/species with ratio > 1.40	-
no taxa/species with ratio > 1.40	-
no taxa/species with ratio > 1.40	-
5.05 – 4.90 – 4.84 – 4.82 – 4.71 – 3.43 (1.60 – 1.49 – 1.40 – 1.44 – 1.55 – 1.58)	27.75

fied Eulimidae, associated with a host. A more detailed study of the population dynamics of their individual species could help to clarify the situation, mainly by stating the role of recruitment on these disparate abundances.

ACKNOWLEDGEMENTS

This article was part of a MSc. thesis. I am very grateful to José M. N. Azevedo who critically read and orientated the thesis. I also acknowledge João Carlos Marques (IMAR/University of Coimbra) and António Frias Martins (University of the Azores) for advice and corrections. Two anonymous reviewers contributed many helpful comments and criticisms. The Marine Biology team of the University of the Azores is acknowledged (José Azevedo, Ana Neto and Ana Cristina Costa, as well as the technicians João Brum and Sandra Monteiro). Several students helped during the sorting phase (Joana Duarte, Margarida Lourenço, Pedro "Bué" Cerqueira, Hugo Renato Calado and Rui Amen). This study was supported by PRAXIS/2/2.1/BIA/169/94. The author was supported by grants FCT (PRAXIS XXI/BIC/2788/96, PRAXIS XXI BM/20521/99 and SFRH/BD/5115/2001).

BIBLIOGRAPHY

ÁVILA, S. P., 1996. Malacological composition of the intertidal zone at a rocky shore in Pico island, Azores. *Abstracts of the II Symposium "Fauna and Flora of the Atlantic islands"*: 27.

ÁVILA, S. P., 1997. Moluscos marinhos recolhidos no Banco "D. João de Castro". *Açoreana*, 8 (3): 331-332.

ÁVILA, S. P., 1998. Zonação intertidal de uma comunidade malacológica numa lagoa costeira localizada na costa Sul da ilha do Pico, Açores. *Açoreana*, 8 (4): 436-486.

ÁVILA, S. P., 2000a. Shallow-water marine molluscs of the Azores: biogeographical relationships. *Arquipélago*, Life and Marine Sciences, Supplement 2 (Part A): 99-131.

ÁVILA, S. P., 2000b. The shallow-water Rissoidae (Mollusca, Gastropoda) of the Azores and some aspects of their ecology. *Iberus*, 18 (2): 1-27.

ÁVILA, S. P. AND ALBERGARIA, A, 2002. The shallow-water Polyplacophora of the Azores and some comments on the biogeographical relationships of the Azorean malacofauna. *Bollettino Malacologico*, 38 (1-4): 41-44.

ÁVILA, S. P. AND AZEVEDO, J. M. N., 1996. Checklist of the marine molluscs of the littoral of Pico island (Azores, Portugal). *Libro de Resúmenes XI Congreso Nacional de Malacología*. Sociedad Española de Malacología, Almería: 106-107.

ÁVILA, S. P. AND AZEVEDO, J. M. N., 1997. Shallow-water molluscs from the Formigas islets, Azores, collected during the "Santa Maria e Formigas 1990" scientific expedition. *Açoreana*, 8 (3): 323-330.

ÁVILA, S. P., AZEVEDO, J. M. N., GONÇALVES, J. M., FONTES J. AND CARDIGOS, F., 1998. Checklist of the shallow-water marine molluscs of the Azores: Pico, Faial, Flores and Corvo islands. *Açoreana*, 8 (4): 487-523.

ÁVILA, S. P., AZEVEDO, J. M. N., GONÇALVES, J. M., FONTES, J. AND CARDIGOS, F., 2000a. Checklist of the shallow-water marine molluscs of the Azores: 2 - São Miguel island. *Açoreana*, 9 (2): 139-173.

ÁVILA, S. P., GONÇALVES, J. M., FONTES, J. AND CARDIGOS, F., 2000b. Additions to the marine molluscs of the Formigas islets, Azores. *Açoreana*, 9 (2): 175-178.

AZEVEDO, J. M. N., 1990. Microgastrópodes. *Expedição Açores 89. Ecologia e Taxonomia do Litoral Marinho. Relatório Preliminar* 1: 54-59.

AZEVEDO, J. M. N., 1991a. *Estudo das comunidades malacológicas fitais do litoral em São Miguel*, Açores. Unpublished MSc. Thesis, Universidade dos Açores.

AZEVEDO, J. M. N., 1991b. Moluscos litorais da ilha de Santa Maria. Santa Maria e Formigas/1990. *Relatórios e Comunicações do Departamento de Biologia*, 19: 43-46.

AZEVEDO, J. M. N. AND MARTINS, A. M. F., 1989. Moluscos Marinhos do Litoral da Ilha Graciosa. *Relatórios e Comunicações do Departamento de Biologia. Expedição Científica Graciosa/88*, 17: 67-72.

AZEVEDO, J. M. N. AND GOFAS, S., 1990. Moluscos marinhos litorais da ilha das Flores. *Relatórios e Comunicações do Departamento de Biologia. Expedição Científica Flores/ 89 (Relatório Preliminar)*, 18: 83-87.

BEGON, M., HARPER, J. L. AND TOWNSEND, C. R., 1996. *Ecology. Individuals, Populations and Communities*. Blackwell Science, London, xii+1068 pp.

BORJA, A., 1986. La alimentación y distributión del espacio en tres moluscos gasterópodos: *Rissoa parva* (da Costa), *Barleeia unifasciata* (Montagu) y *Bittium reticulatum* (da Costa). *Cahiers de Biologie Marine*, 27: 69-75.

BULLOCK, R. C., 1995. The distribution of the molluscan fauna associated with the intertidal coralline algal turf of a partially submerged volcanic crater, the Ilhéu de Vila Franca, São Miguel, Azores. In Martins, A. M. F. (Ed.): The marine fauna and flora of the Azores. Proceedings of the Second International Workshop of Malacology and Marine Biology, Vila Franca do Campo, São Miguel, Azores. *Açoreana*, Suplemento 4: 9-55.

BULLOCK, R. C., TURNER, R. D. AND FRALICK, R. A., 1990. Species richness and diversity of algal - associated micromolluscan communities from São Miguel, Açores. In Martins, A. M. F. (Ed.): The marine fauna and flora of the Azores. Proceedings of the First International Workshop of Malacology São Miguel, Azores. *Açoreana*, Suplemento 2: 39-58.

CHAPMAN, G., 1955. Aspects of the fauna and flora of the Azores. VI. The density of animal life in the coralline alga zone. *Annals and Magazine of Natural History* 12 (8): 801- 805.

CLARKE, J. AND M. AINSWORTH, 1993. A method of linking multivariate community structure to environmental variables. *Marine Ecology Progress Series*, 92: 205-219.

CLARKE, K. R. AND WARWICK, R. M., 1994. *Change in marine communities: an approach to statistical analysis and interpretation*. London: Natural Environment Research Council.

COSTA, A. C. AND ÁVILA, S. P., 2001. Macrobenthic mollusc fauna inhabiting *Halopteris* spp. subtidal fronds in São Miguel island, Azores. *Scientia Marina*, 65 (2): 117-126.

DAUTZENBERG, P., 1889. Contribution à la faune malacologique des Iles Açores. Résultats des dragages effectués par le yacht l'*Hirondelle* pendant sa campagne scientifique de 1887. Révision des mollusques marins des Açores. *Résultats des Campagnes Scientifiques Prince de Monaco*, 1: 1-112.

DAUTZENBERG, P. AND FISCHER, P. H., 1896. Dragages effectués par l'Hirondelle et la Princesse Alice. *Mémoires de la Société Zoologique de France*, 9: 395-498.

DEAN, R. L. AND CONNEL, J. H., 1987. Marine invertebrates in an algal succession. III. Mechanisms linking habitat complexity with diversity. *Journal of Experimental Marine Biology and Ecology*, 109: 249-265.

DIXON, P. S., 1964. *Asparagopsis* in Europe. *Nature*, 204 (4961): 209.

DROUËT, H., 1858. Mollusques Marins des Iles Açores. *Mémoires de la Société Académique de l'Aube*, 22: 1-53.

FELDMANN, J. AND FELDMANN, G., 1942. Recherches sur les Bonnemaisoniacées et leur alternance de générations. *Annales de Sciences Naturelles*, Botanic Series, 11 (3): 75-175.

FIELD, J. G., CLARKE, K. R. AND WARWICK, R. M., 1982. A practical strategy for analysing multispecies distribution patterns. *Marine Ecology - Progress Series*, 8: 37-52.

FRETTER, V. AND GRAHAM, A., 1977. The prosobranch molluscs of Britain and Denmark. Part 2 - Trochacea. *Journal of Molluscan Studies*, Supplement 3: 39-100.

FRETTER, V. AND GRAHAM, A., 1981. The prosobranch molluscs of Britain and Denmark. Part 4 - Marine Rissoacea. *Journal of Molluscan Studies*, Supplement 9: 285-362.

GOFAS, S., 1989. Two new species of *Alvania* (Rissoidae) from the Azores. *Publicações Ocasionais da Sociedade Portuguesa de Malacologia*, 14: 39-42.

GOFAS, S., 1990. The littoral Rissoidae and Anabathridae of São Miguel, Azores. In Martins, A. M. F. (Ed.): The marine fauna and flora of the Azores. Proceedings of the First International Workshop of Malacology São Miguel, Azores. *Açoreana*, Suplemento 2: 97-134.

GRAHAM, A., 1988. Molluscs: Prosobranch and Pyramidellid Gastropods. *Synopsis of the British Fauna (New Series)*, 2: 1-662.

HICKS, L. G. R. F. 1986. Meiofauna associated with rocky shore algae. In Moore, P. G. and Seed, R. (Eds.): *The Ecology of Rocky Coasts*. Columbia University Press, New York: 36-56.

KREBS, C. J., 1989. *Ecological Methodology*. Harper and Row, New York, 654 pp.

MAC ANDREW, R., 1856. Report on the marine testaceous Mollusca of the North-East Atlantic and neighbouring Seas and the physical conditions affecting their development. *Report of the British Association for the Advance of Science*: 1-158.

MORELET, A., 1860. *Notice sur l'Histoire Naturelle des Açores suivie d'une description des Mollusques terrestres de cet Archipel*. J. -B. Baillière et Fils, Paris, 216pp.

NETO, A. I. AND AZEVEDO, J. M. N., 1990. Contribuição para os estudo dos padrões de zonação litoral da ilha das Flores. *Relatórios e Comunicações do Departamento de Biologia. Expedição Científica Flores/89 (Relatório Preliminar)*, 18: 89-102.

NETO, A. I., 1997. *Studies on algal communities of São Miguel, Azores*. Unpublished D. Phil. Thesis, Universidade dos Açores.

NOBRE, A., 1924. Contribuições para a fauna dos Açores. *Annais do Instituto de Zoologia da Universidade do Porto*, 1: 41-90.

NOBRE, A., 1930. *Materiais para o estudo da fauna dos Açores*. Instituto de Zoologia da Universidade do Porto, Porto, 108 pp.

SEED, R., 1986. Ecological patterns in the epifaunal communities of coastal macroalgae. In Moore, P. G. and Seed, R. (Eds.): *The Ecology of Rocky Coasts*. Columbia University Press, New York: 22-35.

WARWICK, R., PLATT, H., CLARKE, K., AGARD, J. AND GOBIN, J., 1990. Analysis of macrobenthic and meiobenthic community structure in relation to pollution and disturbance in Hamilton harbour, Bermuda. *Journal of Experimental Marine Biology and Ecology*, 138: 119-142.

WARWICK, R. AND CLARKE, K., 1993. Comparing the severity of disturbance: a meta-analysis of marine macrobenthic community data. *Marine Ecology Progress Series*, 92: 224-231.

Appendix 1. Molluscs collected at Porto das Baleias, São Vicente, Capelas in July 1996 (non-transformed data).

Apéndice 1. Moluscos recolectados en Porto das Baleias, São Vicente, Capelas en Julio de 1996 (datos no transformados).

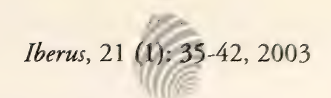
Date (1996 July)	19	19	19	19	19	19	18	18	18	18	18	18	17	17	17	17	17	17	16	16	16	15	15	15		
Depth (m)	4	4	4	5	5	5	8	8	8	12	12	12	14	14	14	16	16	16	22	22	22	27	27	27		
DBUA	707/G	707/T	707/C	708/H	708/I	708/F	703/C	703/E	703/B	704/H	704/A	704/D	701/B	701/A	701/C	702/D	702/E	702/H	694/D	692/B	693/C	690/B	691/C	689/A		
Taxa/Species \ Quadrate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL	%
Acanthochitona fascicularis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0.01
Acmaea virginea	1	0	0	0	0	0	1	0	0	2	2	0	0	1	0	2	0	0	0	0	0	0	0	1	10	0.05
Alvania sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0.01
Alvania angioyi	11	8	37	29	36	4	7	16	17	1	2	9	1	1	0	4	0	8	1	0	10	0	0	3	205	1.05
Alvania cancellata	1	0	1	1	0	1	8	1	6	1	5	4	4	2	2	3	0	2	2	9	22	3	1	1	80	0.41
Alvania mediolittoralis	3	0	0	0	3	0	5	0	0	1	1	0	2	0	1	5	2	0	1	0	9	0	0	0	33	0.17
Alvania poucheti	2	4	3	3	3	0	0	3	2	0	1	2	2	1	1	2	0	11	4	3	18	0	1	0	66	0.34
Alvania sleursi	19	19	34	20	34	23	11	22	18	6	7	15	25	50	11	18	9	13	12	21	117	9	4	9	526	2.69
Anachis avaroides	26	18	36	10	9	14	0	0	0	0	0	1	7	0	2	24	5	2	0	6	4	1	3	0	168	0.86
Anomia ephippium	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0.02
Aplysia cf. *depilans*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.01
Aplysia sp.	0	0	0	0	2	0	0	0	0	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	7	0.04
Arca tetragona	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Bittium sp.	866	699	951	714	1033	381	202	261	389	176	564	914	922	286	563	747	355	225	309	404	622	93	101	159	11936	61.11
Calliostoma sp.	2	3	2	3	0	0	1	1	2	0	0	6	15	2	4	8	5	2	1	0	11	0	2	1	71	0.36
Cardita calyculata	43	24	35	20	16	13	3	7	6	16	17	28	8	12	13	5	8	12	6	0	24	0	0	4	320	1.64
Cerithiopsis tubercularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.01
Cerithiopsis sp.	2	2	5	3	2	0	2	3	0	1	0	1	1	2	0	1	3	0	0	0	0	0	0	0	28	0.14
Cheirodonta pallescens	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Columbella adansoni	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0.01
Crassadoma pusio	34	13	19	12	17	10	5	3	3	13	12	21	33	9	6	31	26	28	15	12	39	1	50	31	443	2.27
Crisilla postrema	0	0	8	0	1	0	0	4	0	0	0	1	0	0	0	0	0	5	0	0	0	0	0	0	19	0.10
Ervilia castanea	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	0	5	0.03
Gibbula magus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.01
Gibbula delgadensis	1	7	9	7	8	0	4	2	10	0	1	0	1	0	1	2	0	0	0	9	1	0	0	0	62	0.32
Gouldia minima	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	3	0.02
Haedropleura septangularis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Haliotis tuberculata	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Jujubinus pseudogravinae	21	20	33	25	53	21	16	59	45	16	15	29	131	17	19	45	9	23	22	0	83	21	12	18	753	3.86
Lasaea adansoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0.01
Limaria hians	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	2	1	7	0.04
Limea loscombii	12	8	6	13	21	2	0	0	0	8	34	13	1	0	2	3	2	4	3	0	7	1	0	3	143	0.73
Manzonia unifasciata	12	11	34	92	156	15	55	102	142	0	6	13	18	8	3	15	2	3	1	5	25	0	0	1	719	3.68
Marshallora adversa	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Mitromorpha azorensis	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	1	5	0	0	2	14	0.07
Monophorus erythrosoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.01
Nassarius incrassatus	1	1	4	1	6	1	1	1	8	2	7	3	14	1	1	5	3	1	4	3	5	0	0	0	73	0.37
Ocinebrina aciculata	8	5	7	5	7	1	0	1	1	0	1	9	26	1	4	20	4	2	4	7	27	1	2	2	145	0.74
Odostomella doliolum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Odostomia sp.	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	4	0	0	0	9	0.05
Omalogyra atomus	1	0	3	2	4	0	0	1	0	0	0	2	0	0	6	1	3	0	0	0	8	0	0	0	31	0.16
Parvicardium sp.	1	0	0	0	0	0	0	1	1	1	3	5	4	2	0	4	0	0	3	0	6	0	0	11	42	0.22
Parvicardium vroomi	47	27	113	69	71	17	6	20	16	21	22	32	10	10	18	11	11	20	3	0	11	0	0	2	557	2.85
Pedipes pedipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.01
Pisinna glabatra	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Rhomboidella prideauxi	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	3	0.02
Rissoa guernei	19	14	46	16	21	11	9	9	7	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	155	0.79
Setia subvaricosa	2	0	4	2	4	0	1	0	2	0	1	4	0	0	0	2	2	1	0	0	0	0	0	0	25	0.13
Setia sp.	1	1	1	2	2	0	0	1	0	0	2	3	0	0	0	0	0	0	1	0	1	0	0	0	15	0.08
Similiphora similior	0	0	1	0	0	3	0	0	1	0	0	0	0	0	0	4	0	2	0	0	1	0	0	0	12	0.06
Sinezona cingulata	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0.04
Trichomusculus semigranatus	6	1	18	1	0	1	1	0	0	1	13	8	1	4	2	2	4	8	1	0	8	1	2	3	86	0.44
Tricolia pullus azorica	183	220	234	162	58	63	166	45	95	19	88	156	222	26	125	258	119	86	71	58	194	27	42	20	2737	14.01
Vitreolina sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.01
TOTAL	1327	1106	1657	1212	1567	582	504	565	771	288	809	1289	1451	436	784	1227	572	460	468	544	1266	160	222	273	19540	100.04

Appendix 2. Molluscs collected at Porto das Baleias, São Vicente, Capelas in July 1997 (non-transformed data).

Apéndice 2. Moluscos recolectados en Porto das Baleias, São Vicente, Capelas en Julio de 1997 (datos no transformados).

Date (1997 July)	16	16	16	10	10	10	15	15	15	15	15	15	14	14	14	11	11	11	11	11	11	12	12	12	14	14	14		
Depth (m)	5	5	5	6	6	6	9	9	9	10	10	10	12	12	12	15	15	15	20	20	20	25	25	25	30	30	30		
DBUA	788	785	766	781	784	782	762	772	764	769+791	771	777	768	778	776	779	783	787	780+790	767	786	789	774	763+773	765	770	775		
Taxa/Species \ Quadrate	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	TOTAL	%
Acanthochitona fascicularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.01
Acmaea virginea	1	1	3	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.06
Alvania angioyi	2	15	9	64	0	0	0	3	2	2	0	0	3	0	0	0	0	31	0	7	0	4	0	17	0	0	0	159	0.97
Alvania cancellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	1	0	0	0	7	0.04
Alvania poucheti	1	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	0	1	0	0	0	16	0.10
Alvania sleursi	4	13	10	49	0	0	0	1	0	2	0	0	0	0	0	0	0	25	22	80	2	23	0	53	0	0	0	284	1.73
Anachis avaroides	6	35	15	3	2	0	0	1	1	7	0	1	1	0	0	2	5	16	1	2	0	3	0	5	0	0	2	108	0.66
Anomia ephippium	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	1	0	0	0	0	5	0	2	0	0	12	0.07
Aplysia punctata	16	6	2	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	30	0.18
Arca tetragona	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0.01
Bittium sp.	764	2609	2831	746	333	25	108	230	224	899	95	65	19	28	22	121	79	647	433	658	13	521	115	641	39	10	99	12374	75.36
Calliostoma sp.	0	3	2	7	0	2	0	0	0	0	0	1	0	0	1	3	1	76	1	2	0	9	0	19	0	0	0	127	0.77
Cardita calyculata	5	8	13	13	1	0	0	0	0	1	0	1	0	0	0	0	0	5	7	28	1	10	0	25	0	0	0	117	0.71
Cerithiopsis cf. *minima*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Cerithiopsis sp.	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	8	0.05
Cheirodonta pallescens	0	0	0	2	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.03
Columbella adansoni	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	0	0	0	0	1	0	0	0	8	0.05
Crassadoma pusio	0	1	3	0	0	0	1	0	1	0	0	0	3	0	1	0	0	10	0	4	0	5	0	7	0	0	0	36	0.22
Crisilla postrema	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0.04
Epitonium sp.	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.01
Eulimidae n. id.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0.01
Gibbula magus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Gibbula delgadensis	15	19	66	46	1	1	0	3	0	7	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	160	0.97
Gouldia minima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.01
Haliotis tuberculata	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.01
Jujubinus pseudogravinae	3	20	35	7	0	0	2	1	2	12	2	6	1	0	2	1	3	52	14	27	0	10	7	9	0	0	0	216	1.32
Lasaea adansoni	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Lepidochitona simrothi	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Limaria hians	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Limea loscombii	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	2	0	0	0	8	0.05
Manzonia unifasciata	0	12	13	31	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	7	0	2	0	5	0	0	0	78	0.48
Marshallora adversa	0	0	0	1	0	0	0	0	0	1	1	1	6	1	1	0	0	3	1	0	0	2	5	2	1	2	3	31	0.19
Melarhaphe neritoides	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Mitra cornea	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	1	1	0	0	8	0.05
Mitromorpha crenipicta	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0.01
Mitromorpha azorensis	0	3	5	5	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	3	0	5	0	2	0	0	0	27	0.16
Monophorus erythrosoma	0	0	0	0	0	1	2	0	0	0	0	0	10	1	0	0	0	0	1	3	0	5	3	4	0	0	0	30	0.18
Monophorus thiriotae	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0.04
Nassarius incrassatus	2	7	6	14	5	1	0	3	1	5	0	1	2	0	3	2	0	3	6	19	4	6	5	5	0	0	0	100	0.61
Ocinebrina aciculata	12	12	15	3	2	1	0	1	2	7	0	0	0	1	3	7	7	52	3	9	1	5	2	14	1	2	0	162	0.99
Odostomella doliolum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.01
Odostomia sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	3	0.02
Omalogyra atomus	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0.02
Papillicardium papillosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	7	0	6	1	0	0	18	0.11
Parvicardium vroomi	64	237	246	125	4	0	0	0	0	79	1	0	4	0	0	0	0	88	40	109	0	8	0	36	0	0	1	1.042	6.35
Patella sp.	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.02
Pollia dorbignyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.01
Raphitoma linearis	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	4	0	4	1	3	0	1	1	19	0.12
Raphitoma purpurea	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.01
Rhomboidella prideauxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0	4	0.02
Rissoa guernei	0	10	17	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0.21
Setia sp.	0	0	0	2	1	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	8	0.05
Setia subvaricosa	3	8	3	8	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	36	0.22
Similiphora similior	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	3	0	0	0	0	0	0	0	10	0.06
Sinezona cingulata	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0.04
Skeneopsis planorbis	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.01
Stramonita haemastoma	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	5	0.03
Trichomusculus semigranatus	0	5	8	9	0	0	0	0	0	0	0	0	0	0	1	0	0	11	2	23	0	4	2	10	0	0	0	75	0.46
Tricolia pullus azorica	68	140	111	99	28	11	7	9	2	59	5	19	9	0	18	7	8	127	32	68	0	34	2	123	4	1	2	993	6.05
Turbonilla sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.01
TOTAL	967	3173	3420	1269	380	44	127	254	240	1087	104	96	68	33	57	143	104	1174	569	1083	22	680	147	1006	49	16	108	16420	100.00

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The genus *Granulina* (Gastropoda, Marginellidae) from the Atlantic Iberian Pliocene with description of a new species from Portugal

El género *Granulina* (Gastropoda, Marginellidae) en el Plioceno Atlántico Ibérico y descripción de una especie nueva para Portugal

Rafael LA PERNA*, Bernard LANDAU** and Carlos Marques da SILVA***

Recibido el 27-XI-2001. Aceptado el 16-IX-2002

ABSTRACT

The marginellid *Granulina choffati* n.sp. is described from Pliocene, uppermost Zanclean to lower Piacenzian, shallow-water sandy beds cropping out in central-west Portugal. This is the first record of *Granulina* from the Atlantic European Pliocene. *G. choffati* n.sp. is markedly similar to *G. elliptica* La Perna, 2000, known from the Pliocene of Sicily, and both species share close similarities to the Recent West African species *G. nofronii* Smriglio, Gubbioli and Mariottini, 2001. The two Pliocene species are regarded as thermophilic elements of southern affinity. The Pliocene distribution of *Granulina* in the East Atlantic ranged at least up to 40°N along the Iberian coasts and it is hypothesized that this limit shifted southward because of the Plio-Pleistocene cooling pulses.

RESUMEN

Se describe una nueva especie de Marginellidae, *Granulina choffati* n.sp., procedente de afloramientos arenosos someros del Plioceno (Zancliense superior-Piacenziense) en el centro-oeste de Portugal. Esta es la primera cita del género *Granulina* para el Plioceno Atlántico Europeo. *G. choffatti* n.sp. es muy similar a *G. elliptica* La Perna, 2000, conocida en el Plioceno de Sicilia, y ambas especies muestran marcadas semejanzas a la especie actual del oeste de Africa, *G.nofronii* Smriglio, Gubbioli y Mariottini, 2001. Las dos especies pliocénicas se consideran elementos termófilos con afinidad meridional. La distribución de *Granulina* en el Plioceno del Este Atlántico llegaba hasta almenos 40° N en la costa ibérica y se presume que este límite se haya trasladado hacia el sur a causa de crisis de enfriamiento plio-pleistocénico.

KEY WORDS: Gastropoda, *Granulina*, new species, paleobiogeography, palaeoclimatology, Pliocene, Portugal.
PALABRAS CLAVE: Gastropoda, *Granulina*, especie nueva, paleobiogeografía, paleoclimatología, Plioceno, Portugal.

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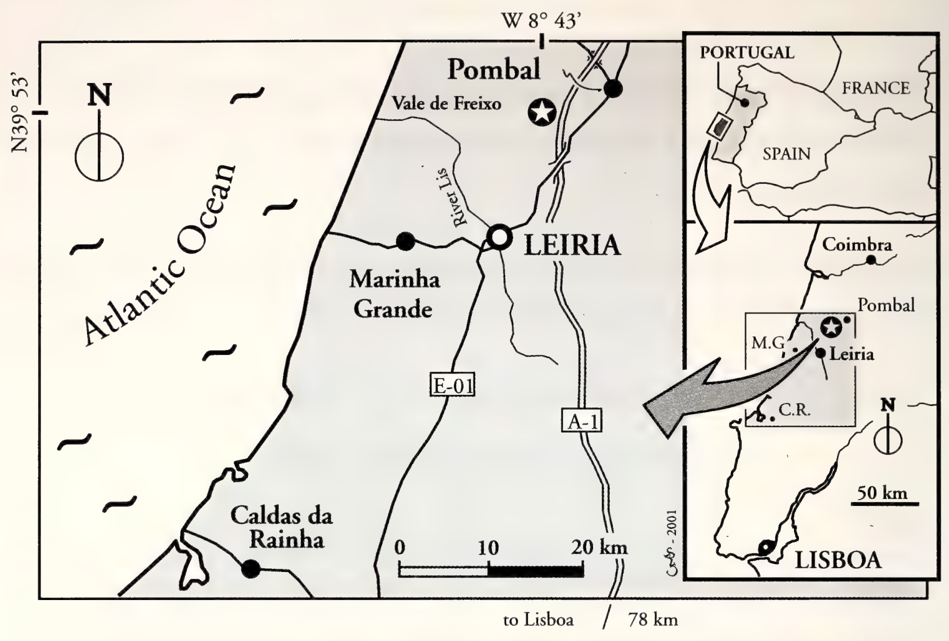


Figure 1. Location of the Vale de Freixo Pliocene outcrop in central-west Portugal.
Figura 1. Localización del yacimiento de Vale de Freixo en en centro-oeste de Portugal.

INTRODUCTION

Several recent works devoted to the marginellid genus *Granulina* Jousseame, 1888 have provided a fairly good knowledge of the composition of this genus in the Mediterranean and the adjacent Atlantic (Ibero-Moroccan Gulf south to Gulf of Guinea), and also in the Mediterranean Pliocene and Pleistocene (La Perna, Landau and Marquet, 2002, with references).

Granulina is a "southern" genus, not present in the North European waters. The Iberian coasts are the northernmost area of distribution of this genus in the East Atlantic, but little is known about its occurrence in this area. Nobre (1936) reported *G. clandestina* (Brocchi, 1814) from Portugal with no precise indication of locality, but this record was based on a misidentification, as *G. clandestina* is an extinct Pliocene species whose name was widely and uncritically used until the revision made by Gofas (1992). A list of modern European and Northwest African marginellids (Muñiz Solis, 1987) and a recent popular book on Portuguese molluscs (Macedo, Macedo and Borges, 1999) reported several species of *Granulina*, including "*G. clandestina*". None of the other species reported, *G. guancha* (d'Orbigny, 1839), *G. minusculina* (Locard, 1897) and *G. parvulina* (Locard, 1897) (= *G. occulta* Monterosato, 1869) is proved to occur north of the Ibero-Moroccan Gulf. Gofas (1992) stated that no species of this genus has ever been found in the Biscay Bay. Although the occurrence of *Granulina* in the Ibero-Moroccan Gulf is documented (Gofas, 1992), no species was found in the Sagres and Olhão areas (southern Portugal, Ibero-Moroccan-Gulf), in spite of extensive samplings carried on by the Muséum National d'Histoire Naturelle (Paris) in 1988 (Gofas, pers. comm.). Therefore, the northern limit of *Granulina* in the Eastern Atlantic must be within the Ibero-Moroccan Gulf excluding the southern Portugal, at least for the shelf species (Fig. 10).

No representative of *Granulina* had been so far reported from the Atlantic European Pliocene, but there are a few records from the Upper Oligocene and Lower Miocene of the Aquitaine basin and from the Upper Oligocene of the North Sea basin (LOZOUET, 1997 and pers. comm., 2002). Recent studies on a rich molluscan fauna from Pliocene beds cropping out at Vale de Freixo, in central-west Portugal (Fig. 1), allowed the discovery of several specimens of the genus, most of them belonging to an undescribed species. Nevertheless, this new species is not the only one of the genus occurring at Vale de Freixo, a single shell of another one was found, but it is too badly preserved to be unequivocally determined. It is however similar to *G. detruncata*, recently described from the Pliocene of Malaga (southern Spain) by LA PERNA *ET AL.* (2002).

Like the previous study on the Pliocene species from the southern Iberian Peninsula (LA PERNA *ET AL.*, 2002), the present work focuses on the history of *Granulina* in the Mediterranean and adjacent Atlantic through the Plio-Quaternary.

SYSTEMATICS

Class GASTROPODA Cuvier, 1797
Order NEOGASTROPODA Thiele, 1929
Family MARGINELLIDAE Fleming, 1828
Genus *Granulina* Jousseame, 1888

Granulina choffati n.sp. (Figs. 2-6)

Type material: Holotype and 3 paratypes, National Natural History Museum of the Lisbon University (MNHN/UL.II.413-416), 9 paratypes in B. Landau coll., 1 paratype in R. La Perna coll.
Examined material: Only the type material.
Type locality: Vale de Freixo, Pombal region in central-west Portugal (Fig. 1), Pliocene, uppermost Zanclean to lower Piacenzian fine sandy beds.
Etymology: After Léon-Paul Choffat (born in 1849, in Porrentruy; died in 1919, in Lisbon), classical Portuguese geologist and palaeontologist of Swiss origin who discovered and studied the first Pliocene outcrops and molluscan faunas from Portugal.

Description: Shell minute, with immersed spire, elliptic-elongate in shape, maximum diameter at mid-length of shell, lenght/diameter *ca* 1.5. Posterior end slightly truncated to rounded, covered by a thin more or less developed callus. Siphonal notch faintly distinct. Lip moderately thickened, forming a regular arch, broader at mid length. Lip denticulations moderately fine, well defined, somewhat roundish. Four columellar plications, the uppermost two slightly smaller, obscurely excavated inside aperture by a shallow sulcus. Thin ill-defined inner parietal callus ridge running from posterior end to columellar plications. Outer parietal callus not distinct. Aperture narrow. Surface smooth but crossed by fairly well distinct growth striae. Holotype: lenght 2.1 mm, diameter 1.4 mm. Paratypes: lenght 1.8 to 2.2 mm.

Distribution: So far, only known from the type locality. The material comes from a Pliocene mostly sandy sequence, containing a particularly diverse and well preserved fauna. Recent studies on this fauna (GILI, SILVA AND MARTINELL, 1995; SILVA, 1996; NOLF AND SILVA, 1997; SILVA, LANDAU AND MARTINELL, 2000; SILVA, 2001) indicate a marine shallow-water (infralittoral) environment with relatively high water temperatures. The age of the Vale de Freixo fauna was referred to uppermost Zanclean to lower Piacenzian (*Discoaster tamalis*, CN12a, biozone of OKADA AND BUKRY, 1980) by CACHÃO (1990; emended by SILVA, 2001,

by means of Strontium $^{87}Sr/^{86}Sr$ dating) and to the Mediterranean Pliocene Molluscan Unit 1 of RAFFI AND MONEGATTI (1993) and MONEGATTI AND RAFFI (2001) by SILVA (2001). For general stratigrafical setting, Vale de Freixo graphic columnar section, and additional references see SILVA *ET AL.* (2000).

Remarks: The most similar fossil species is *Granulina elliptica* La Perna, 2000 (Figs. 7-9) described from the Lower-Middle Pliocene of Sicily (LA PERNA, 2000) (Fig. 10). In both species the shell has a markedly elliptic shape, with maximum diameter at mid length. Such a shape is rather unusual for the genus, since the maximum diameter often is within the posterior (adapical) third, giving an ovate (rather than elliptic) shell outline. *G. choffati* n.sp. is even more regularly elliptic than *G. elliptica*, in which the maximum diameter tends to be slightly above the mid point. A parietal callus ridge almost inside the aperture is present in the shell of both species, as well as an inner parietal sulcus producing an "excavation" of columellar plications (LA PERNA *ET AL.*, 2002). However, the callus ridge, sulcus and excavated plications are much more developed in *G. elliptica* than in *G. choffati* n.sp., and these are the main distinctive features between these species. Lip denticulations are somewhat roundish in both species, particularly in *G. elliptica*, in which they are also notably coarser. The outer parietal callus (LA PERNA, 1999; LA PERNA *ET AL.*, 2002) is not distinct in both species. In *G. elliptica* the shell is more swollen, and the outer lip lacks the central broadening which is more or less developed in *G. choffati* n.sp. It is also worth noting the shallow-water (infralittoral) distribution of both species.

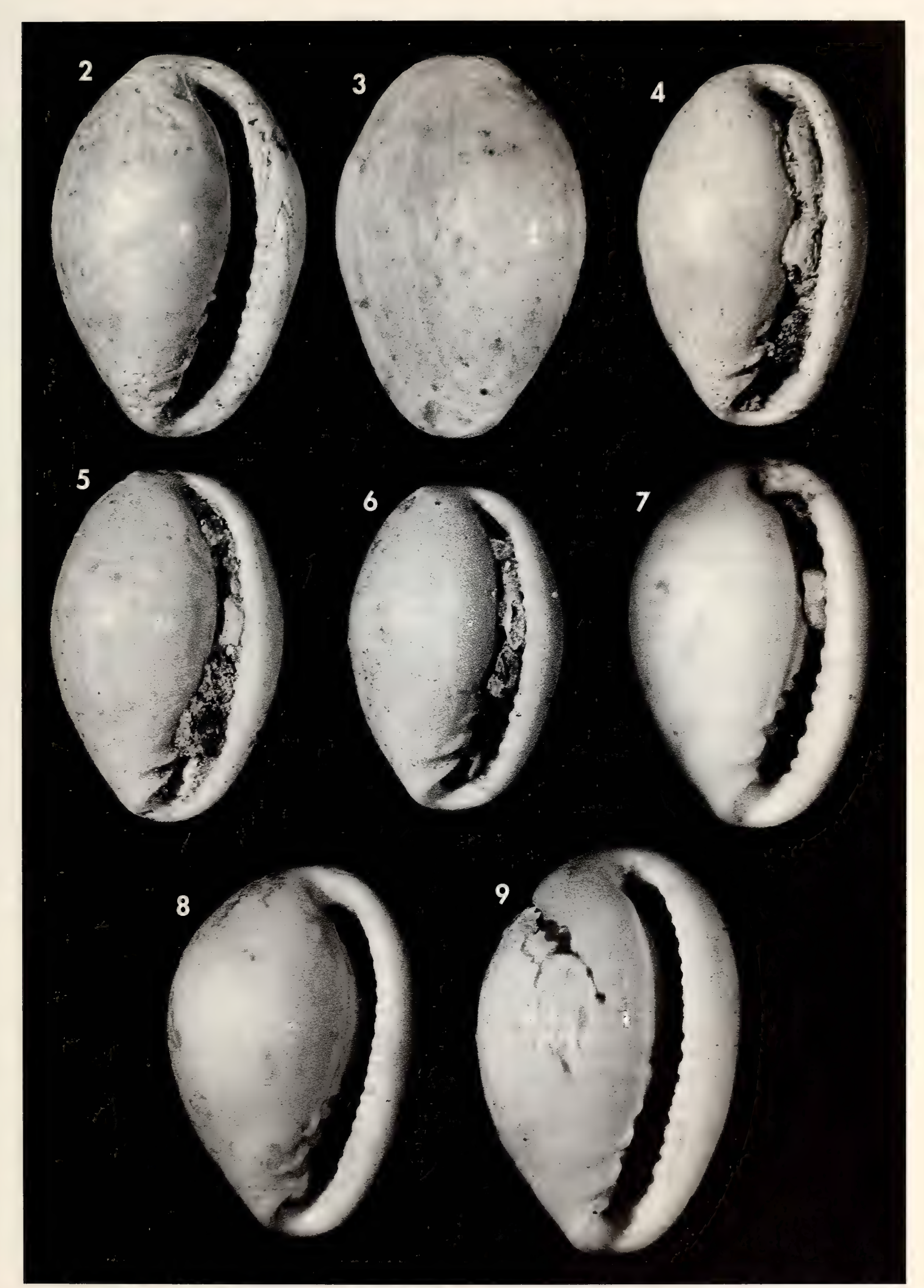
A Recent shelf species, *G. nofronii*, recently described by SMRIGLIO, GUBBIOLI AND MARIOTTINI (2001) from Northwest Africa (Western Sahara and Mauritania) shares similarities with the two Pliocene species. Its elliptic shape is particularly similar to that of *G. choffati* n.sp., including a certain broadening of the lip in its median part. Also plications shape and callus ridge strength are particularly similar to those of *G. choffati* n.sp., while the coarse lip denticulation resembles that of *G. elliptica*. *G. nofronii* differs from both species by being a little larger, slightly more slender and rostrated, and with a better defined siphonal slope-break.

DISCUSSION

Although most species of *Granulina* differ from one other only by subtle conchological differences, a number of shell features have been recently considered (GOFAS, 1992; LA PERNA, 1999; BOYER AND ROLÁN, 1999; LA PERNA *ET AL.*, 2002). As discussed by LA PERNA *ET AL.* (2002), morphological affinities may be of help to infer phyletic closeness within this genus, in spite of such a monotonous conchological pattern. An attempt of clustering some Pliocene, Pleistocene and Recent species was made by LA PERNA *ET AL.* (2002).

When *G. elliptica* was described, the impossibility to recognise any marked similarity with other fossil or living species was stressed, but the finding of *G. choffati* n.sp. now deprives *G. elliptica* of such a "uniqueness". These two species are so similar that a close phyletic relation between them is highly likely.

LA PERNA *ET AL.* (2002) recognised amongst the Mediterranean Pliocene shelf species of *Granulina* a mixture of warm and warm-temperate taxa, due to the occurrence of some extinct species with "African affinities", such as *G. clandestina* (a similar Recent species, *G. parilis* Gofas and Fernandes, 1988, is known from the Gulf of Guinea), together with a more temperate stock, well represented by *G. marginata* (Bivona, 1832) and *G. boucheti* Gofas, 1992, which are now the most common shallow-water species of the genus in the Mediterannean.



Figures 2-6. *Granulina choffati* n.sp. 2, 3: holotype, 2.1 mm; 4: paratype 1, 2.0 mm; 5: paratype 2, 2.0 mm; 6: paratype 3, 1.8 mm. Figures 7-9. *Granulina elliptica*. 7: holotype, 2.1 mm; 8: paratype, 2.1 mm; 9: paratype, 2.3 mm.

Figuras 2-6. Granulina choffati *n.sp. 2, 3: holotipo, 2.1 mm; 4: paratipo 1, 2.0 mm; 5: paratipo 2, 2.0 mm; 6: paratipo 3, 1.8 mm. Figuras 7-9.* Granulina elliptica. *7: holotipo, 2.1 mm; 8: paratipo, 2.1 mm; 9: paratipo, 2.3 mm.*

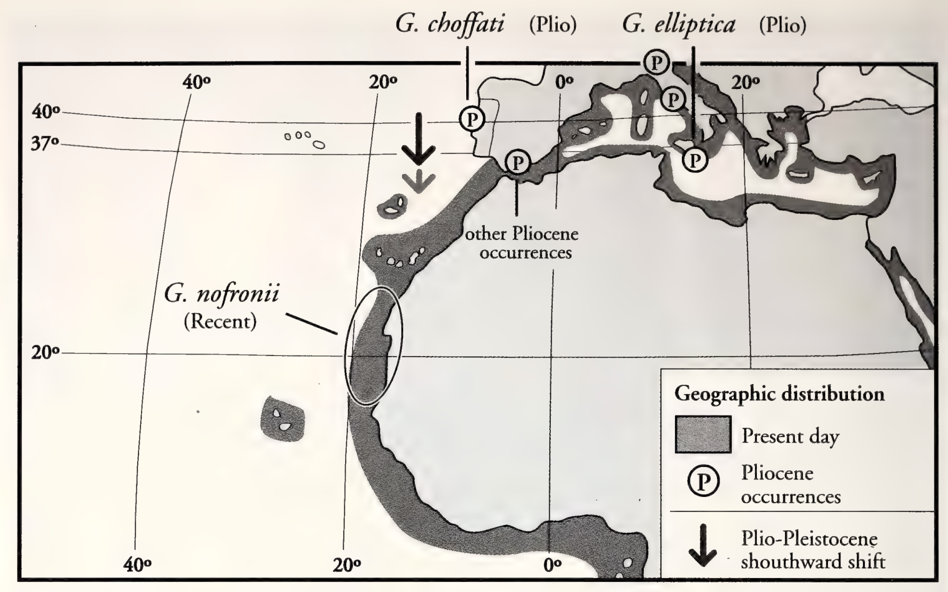


Figure 10. Present day Eastern Atlantic and Mediterranean distribution of *Granulina* and occurrences of *Granulina choffati* n.sp., *G. elliptica* La Perna, 2000, and *G. nofronii* Smriglio *et al.*, 2000.
Figura 10. Distribución actual en el Atlántico este y Mediterráneo de Granulina *y citas de* Granulina choffati *n.sp.*, G. elliptica *La Perna, 2000, and* G. nofronii *Smriglio* et al., *2000.*

Also *G. elliptica* and *G. choffati* n.sp. may thus represent a group of species with a southern affinity, if the West African *G. nofronii* is regarded as a living representative of the same lineage. This does not imply a direct phyletic relation between these two species (*i.e.*, *G. elliptica* may be not the ancestor of *G. choffati* n.sp., or vice-versa). For the time being, the key point is to recognize groups of closely related species, sharing similar ecologic and biogeographic distribution. Changes in the distribution of these groups should be referred to major climatic changes, whose strong effects on distribution and diversity of Plio-Pleistocene benthic faunas are well known (*e.g.*, DI GERONIMO, DI GERONIMO, LA PERNA, ROSSO AND SANFILIPPO, 2001; MONEGATTI AND RAFFI, 2001). Also the distribution and composition of *Granulina* and of marginellids in general, which typically have a warm-water distribution, must have been controlled by the Plio-Pleistocene cooling events. Actually, the diversity of *Granulina* in the shelf waters was higher in the Pliocene than in the present days (LA PERNA *ET AL.*, 2002 and unpubl. data; CHIRLI, 2002). Extinction of warm-water taxa, and/or local disappearance due to southward shifting, is the most important aspect of the Plio-Pleistocene history of shelf molluscs (*e.g.*, STANLEY AND RUDDIMAN, 1995; MONEGATTI AND RAFFI, 2001).

CONCLUSIONS

During the Pliocene, the genus *Granulina* ranged at least up to *ca.* 40°N (the latitude of Vale de Freixo) along the West Iberian coasts (Fig. 10). It should be admitted that such a Pliocene distribution represented but a step in the overall southward shift of *Granulina* in the Eastern Atlantic since its appearance (or its first documented occurrence) at higher latitudes in the Upper Oligocene (see introduction). Other Portuguese

Pliocene gastropod taxa show evidences of a similar southward migration (*e.g.*, among *Nassarius*, GILI, SILVA AND MARTINELL, 1995; *Solariella*, SILVA, LANDAU AND MARTINELL, 2000). From the Middle Pliocene (*ca.* 3.0 Ma) on, the southward shift of the Atlantic species of *Granulina* was, probably, more intense than previously, reflecting the sucessive Plio-Pleistocene sharp cooling pulses, the species with stronger termophilic affinities becoming rapidly extinct. The same pattern of extinction and/or local disappearance also occurred in the Mediterranean, where, simultaneously, some endemic taxa were appearing (LA PERNA *ET AL.*, 2002).

ACKNOWLEDGEMENTS

The authors wish to acknowledge Pierre Lozouet (Muséum National d'Histoire Naturelle, Paris) and Serge Gofas (Universidad de Málaga) for relevant information, Isabel Puigdevall (Università di Bari) for her kind assistance with Spanish language, two anonymous referees and Serge Gofas for critical reading and comments.

Contribution of the Portuguese FCT Project 32724/99-Comparative (palaeo)-environmental analysis of oceanic and coastal domains, over the last 20 Ma, based on calcareous nannoplankton (CANAL), co-financed by FEDER.

BIBLIOGRAPHY

BOYER, F. AND ROLÁN, E. 1999. *Granulina fernandesi* (Gastropoda: Volutacea), a new species from Cape Verde Islands, and some considerations on the genus *Granulina*. *Iberus*, 17 (2): 1-10.

CACHÃO, M., 1990. Posicionamento biostratigráfico da Jazida Pliocénica de Carnide (Pombal). *Gaia*, 2: 11-16.

CHIRLI, C., 2002. *Malacofauna Pliocenica Toscana. Vol. 3. Muricoidea e Cancellarioidea*. Stamperia e Legatoria Pisana, Agnano Pisano, 92 pp. + 37 pls.

DI GERONIMO, I., DI GERONIMO, R., LA PERNA, R., ROSSO, A. AND SANFILIPPO, R., 2001. Cooling evidence from Pleistocene shelf assemblages in SE Sicily. In Hart, M.B (Ed.): Climates: Past and Present. Geological Society, London, Special Publication, 181: 113-120.

GILI, C., SILVA, C.M. DA AND MARTINELL, J., 1995. Pliocene nassariids (Mollusca: Neogastropoda) of central-west Portugal. *Tertiary Research*, 15 (3): 95-110.

GOFAS, S., 1992. Le genre *Granulina* (Marginellidae) en Méditerranée et dans l'Atlantique Oriental. *Bollettino Malacologico*, 28 (1-4): 1-26.

LA PERNA, R., 1999. Pleistocene and Recent Mediterranean species of *Granulina* (Gastropoda, Marginellidae), with description of four new species. *Bollettino Malacologico*, 34 (1-4): 43-52.

LA PERNA, R., 2000. *Granulina elliptica* n. sp. and comments on the Mediterranean Pliocene species of *Granulina* (Gastropoda, Marginellidae). *Bollettino Malacologico*, 35 (1-4): 53-55.

LA PERNA, R., LANDAU, B. AND MARQUET, R., 2002. Species of *Granulina* (Gastropoda, Marginellidae) from the Pliocene of Málaga (southern Spain) with description of four new species. *Cainozoic Research*, 1 (1-2): 111-120.

LOZOUET, P., 1997. Le domaine atlantique européen au Cènozoïque moyen: diversité et évolution des gastéropodes. Unpublished Thesis (Paris MNHN), 309 pp. + annexes 52 pp., 112 figs.

MACEDO, M.C., MACEDO, M.I. AND BORGES, J.P., 1999. *Conchas Marinhas de Portugal*. Editorial Verbo, Lisboa, 516 pp.

MONEGATTI, P. AND RAFFI, S., 2001. Taxonomic diversity and stratigraphic distribution of Mediterranean Pliocene bivalves. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 165: 171–193.

MUÑIZ SOLIS, R., 1987. Catalogo preliminar de la familia Marginellidae Fleming, 1828 (Gastropoda, Prosobranchia) en las provincias Lusitana, Mediterránea y Mauritana. *Reseñas Malacologicas*, V, Sociedad Española de Malacologia, 60 pp.

NOBRE, A., 1936. *Moluscos Marinhos de Portugal*. II vol. Companhia Editora do Minho, Barcelos, 378 pp.

NOLF, D. AND SILVA, C.M. DA, 1997. Otolithes de poissons pliocènes (Plaisancien) de Vale de Freixo, Portugal. *Revue de Micropaléontologie*, 40 (3): 273-282.

OKADA, H. AND BUKRY, D., 1980. Supplementary modification and introduction of code numbers to the low-latitude coccolith biostratigraphic zonation. *Marine Micropaleontology*, 5: 321-325.

RAFFI, S. AND MONEGATTI, P., 1993. Bivalve taxonomic diversity throughout the Italian Pliocene as a tool for climatic-oceanographic and stratigraphic inferences. Proc. 1st RCANS Congr., Lisbon 1992. *Ciências da Terra (UNL)*, 12: 45-50.

SILVA, C.M. DA, 1996. Moluscos pliocénicos da região de Caldas da Rainha - Marinha Grande - Pombal (Portugal). III. Neogastropoda. Conidae. *Gaia*, 12: 37-43.

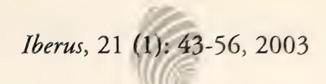
SILVA, C.M. DA, 2001. *Gastrópodes Pliocénicos Marinhos de Portugal. Sistemática, Paleoecologia, Paleobiologia, Paleobiogeografia.* Ph. D. Thesis, University of Lisbon, 747 pp.

SILVA, C.M. DA, LANDAU B. AND MARTINELL J., 2000. The genus *Solariella* (Mollusca, Archaeogastropoda) from the Pliocene of Vale de Freixo, Portugal: palaeobiogeographic and palaeoclimatic implications. *Contributions to Tertiary and Quaternary Geology*, 37 (3-4): 57-65.

SMRIGLIO, C., GUBBIOLI, F. AND MARIOTTINI, P., 2001. New data concerning the presence of *Granulina* Jousseaume, 1888 (Neogastropoda, Cystiscidae) along the West African coast and description of four new species. *La Conchiglia*, 287: 54-59.

STANLEY, S.M. AND RUDDIMAN, W.F., 1995. Neogene Ice Age in the North Atlantic Region: Climatic Changes, Biotic Effects, and Forcing Factors. In AAVV: *Effects of Past Global Change on Life*, Studies in Geophysics, Board on Earth Sciences and Resources, Communications on Geosciences, Environment, and Resources, National Research Council, National Academic Press, Washington D.C., pp. 118-133.

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Solenogastres molluscs from the BENTART Collection (South Shetland Islands, Antarctica), with a description of a new species

Moluscos Solenogastres de la Colección BENTART (Islas Shetland del Sur, Antártida), con la descripción de una nueva especie

Oscar GARCÍA-ÁLVAREZ* and Victoriano URGORRI**

Recibido el 27-VI-2002. Aceptado el 25-IX-2002

ABSTRACT

Four specimens from the BENTART Collection are studied (South Shetland Islands and Bransfield Strait, Antarctic). Two specimens were identified as: *Rhopalomenia carinata* Salvini-Plawen, 1978 collected on a muddy, gravel bottom at a depth of 710 m, off Livingston Island, and *Rhopalomenia rhynchopharyngeata* Salvini-Plawen, 1978 from a muddy bottom at a depth of 235 m off Livingston Island. One specimen, collected from a fine muddy and sandy bottom at a depth of 80 m off Livingston Island, belongs to the genus *Neomenia*, presenting features which well distinguish the same from known species. It is not, however, described as a new species since the anatomic organisation of the posterior part of the animal is unknown. And one specimen, collected on a muddy bottom at a depth of 80 m off Livingston Island, is described as a the new species *Dorymenia parvidentata*. This article report on the Solenogastres previously studied in the BENTART Collection.

RESUMEN

Se estudian cuatro ejemplares de la Colección BENTART (Islas Shetland del Sur y estrecho de Bransfield, Antártida). Dos ejemplares fueron identificados como: *Rhopalomenia carinata* Salvini-Plawen, 1978 recogida en un fondo fangoso y de gravas a 710 m de profundidad en la Isla Livingston y *Rhopalomenia rhynchopharyngeata* Salvini-Plawen, 1978 procedente de un fondo fangoso a 235 m de profundidad en la Isla Livingston. Un ejemplar, procedente de un fondo de fango fino y arena a 80 m de profundidad en la Isla Livingston, pertenece al género *Neomenia* y presenta rasgos que lo separan claramente de las especie conocidas, pero no es descrito como una nueva especie ya que no se conoce la organización anatómica de la parte posterior del animal. Y un ejemplar, recogido en una fondo fangoso a 80 m de profundidad en la isla Livingston, es descrito como la nueva especie *Dorymenia parvidentata*. Se informa sobree los Solenogastres ya estudiados de la Colección BENTART.

KEY WORDS: *Neomenia* sp., *Rhopalomenia carinata*, *Rhopalomenia rhynchopharyngeata*, *Dorymenia parvidentata*, Mollusca, Solenogastres, Antarctica.

PALABREAS CLAVE: *Neomenia* sp., *Rhopalomenia carinata*, *Rhopalomenia rhynchopharyngeata*, *Dorymenia parvidentata*, Moluscos, Solenogastros, Antártida.

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INTRODUCTION

During the Spanish campaigns BENTART'94 and BENTART'95, for the study of the Antarctic benthos off the Livingston and Deception Islands (South Shetland Islands) and in the Bransfield Strait, north of the Antarctic Peninsula, 17 specimens of Solenogastres Molluscs were collected. Research had previously been conducted in this area to gain knowledge of the benthonic fauna (U.S. Antarctic Research Program, 1961-1972), resulting in the description of 23 species of Solenogastres (SALVINI-PLAWEN, 1978). Study of the BENTART Collection of Solenogastres revealed that the majority of specimens collected belonged to new species. *Dorymenia troncosoi* García-Álvarez, Urgorri and Salvini-Plawen, 1998, 5 specimens: 4 collected south of Livingston Island on muddy bottoms at a depth of 65-66 m, and 1 specimen collected north of the same Island on a muddy bottom at a depth of 240 m (GARCÍA-ÁLVAREZ, URGORRI AND SALVINI-PLAWEN, 1998). *Dorymenia hesperidesi* García-Álvarez, Urgorri and Salvini-Plawen, 2000, 1 specimen collected on a muddy bottom at a depth of 235 m south of Livingston Island; *Dorymenia menchuescribanae* García-Álvarez, Urgorri and Salvini-Plawen, 2000, 6 specimens: 5 collected south of Livingston Island on *Ophidiogorgia paradoxa* Bayar, 1980, at a depth of 50 m, and 1 specimen collected south of the same Island on a muddy bottom at a depth of 66 m (GARCÍA-ÁLVAREZ, URGORRI AND SALVINI-PLAWEN, 2000). *Ocheyoherpia bursata* García-Álvarez and Urgorri, 2003, 1 specimen collected off Deception Island on a gravel bottom at a depth of 248 m (GARCÍA-ÁLVAREZ AND URGORRI, 2003, in press). In this paper, 4 specimens from the BENTART Collection are studied. Two specimens were identified as belonging to two species previously known in the study area: *Rhopalomenia carinata* Salvini-Plawen, 1978 collected on a muddy and gravely bottom at a depth of 710 m off Livingston Island and *Rhopalomenia rhynchopharyngeata* Salvini-Plawen, 1978 from a muddy bottom at a depth of 235 m off Livingston Island. One specimen belonging to the genus *Neomenia* presented features, which well distinguish it from known species, although it is not described as a new species since the anatomic organisation of the posterior part of the animal is unknown, this specimen was collected from a fine muddy and sandy bottom, at a depth of 80 m off Livingston Island. And one specimen, collected on a muddy bottom at a depth of 80 m off Livingston Island, is described as a the new species *Dorymenia parvidentata*.

MATERIAL AND METHODS

The specimens studied were fixed and preserved in 70% alcohol. The sclerites were studied by separation of small pieces of cuticle from the central dorsal area of the body and from the ventral groove. These pieces were treated with 5% sodium hypochlorite for 12 hours in order to isolate the sclerites; they were them rinsed with distilled water, dried under a heater at 40°C and mounted using synthetic resin. For the anatomical study, the specimen were decalcified in an ethylenediaminetetracetic acid (EDTA) solution 12 hours, embedded in paraffin and a series of 10 µm cross sections cut which were stained with Azan of Heidenhain. The anatomy was reconstructed from the serial sections.

RESULTS

Order NEOMENIAMORPHA Pelseneer, 1906

Family NEOMENIIDAE Ihering, 1876

Genus *Neomenia* Tullberg, 1875

Neomenia sp.

Material examined: One specimen, 3.7 mm in length and 1.4 mm in width at the anterior part, and 0.7 mm in width at the posterior part (sectioned into 10 µm transversal series). Collected at station 7-BOX-3 (62° 44′ 17″ S; 60° 28′ 11″ W) with a box-corer trawl on a fine muddy and sandy bottom, at a depth of 80 m off Livingston Island (South Shetland Islands, Antarctic) during the Spanish campaign, BENTART'95, for the study of the Antarctic benthos,.

Description: The body of the animal is wider at the anterior end than at the posterior end, and gradually narrows in diameter between the two (Fig. 1A). The sclerites do not appear to protrude from the cuticle, but they have a very shiny appearance. The ventral groove is well visible. In alcohol the colour of the animal is yellowish white. The cuticle is 30-50 µm thick with papillae at the base. Underneath the epidermis there is a thick subepithelial layer matrix up to 70 µm (Fig. 2A). The mantle produces three types of sclerites: elongated laminate scales not forming grooves (120 µm x 14 µm) (Fig. 1B); solid slightly curved acicular spicules (100µm x 4.5 mm) (Fig. 1C); elongated scales in the shape of grooves (100 µm x 16 µm) (Fig. 1D). The pedal pit is located below the oral opening and the anterior part of the pharynx (Fig. 1E). In a preserved state, it has a narrow opening. Its epithelium is ciliated and at its end the three folds are visible that continue on to the pedal groove (Fig. 2B). These folds are likewise ciliated and the middle one is larger than the two lateral ones. At the end of the body, the two lateral folds become smaller, and only the middle fold is still present. In the pallial cavity 10 to 12 respiratory folds are visible, but due to the poor condition of the animal, it is impossible to affirm that this is the correct number. Moreover, the number of folds may depend on the size and the maturity of the animal. The buccal opening is found at the posterior area of the atrium (Fig. 1E). It represents the anterior end of a short tube with three internal thickenings or large lips, two dorsolateral and one ventral that are in rostral prolongation of the pharynx (Figs. 1E, 2A). The two dorsolateral lips are separated by a mid dorsal slit, but they are never separated and set off from the walls where the buccal tube is. A lateral slit from each dorsolateral lip separates the ventral lip. These slits also continue in a ventral space of this lip, separating the latter as a tongue-like formation from the wall of the buccal tube. The foregut continues into a long pharynx having a longitudinally pleated folded wall, its epithelium is covered by a fine cuticular layer. The middle portion of the pharynx is surrounded by glands and by a strong circular musculature which cause it to narrow (Figs. 1E, 2C). It opens into the midgut through a sphincter formed by a very strong circular musculature (Figs. 1E, 2D). There is no radula or radular sac and no ventral foregut glandular organs are elaborated. No rostral caecum of the midgut is present (Fig. 1E), the latter shows lateral constrictions due to the dorsoventral musculature. The cerebral ganglion is large, located dorsally to the pharynx in the middle portion above the ring of circular musculature (Fig. 1E). At either side of the cerebral ganglion, there is one lateral ganglion (Fig. 1E). A short distance behind these lateral ganglion, there are two connectives which emerge from each side of the cerebral ganglion: the strongest pair (270 µm x 20 µm each) runs vertically to join the buccal ganglion (Figs. 1E, 2C). The two buccal ganglia are located ventrolaterally of the pharynx throughout the area of strong circular musculature. They are interconnected by a ventral commissure of the pharynx. The second connectives runs to the ventral ganglia that are large and rounded (100 µm in diameter), joined with each other by a single commissure (Fig. 2B) and located above the beginning of the pedal groove and ventrally in the mid-area of the pharynx with its strong circular musculature. The atrium opens at the anterior

end of the body through a narrow slit in a dorsoventral direction. The atrium is large and in its dorsal and lateral walls, it presents several papillae forming groups of 4-7, joined together in one base (Fig. 2A).

Order CAVIBELONIA Salvini-Plawen, 1978
Family RHOPALOMENIIDAE Salvini-Plawen, 1978
Genus *Rhopalomenia* Simroth, 1893

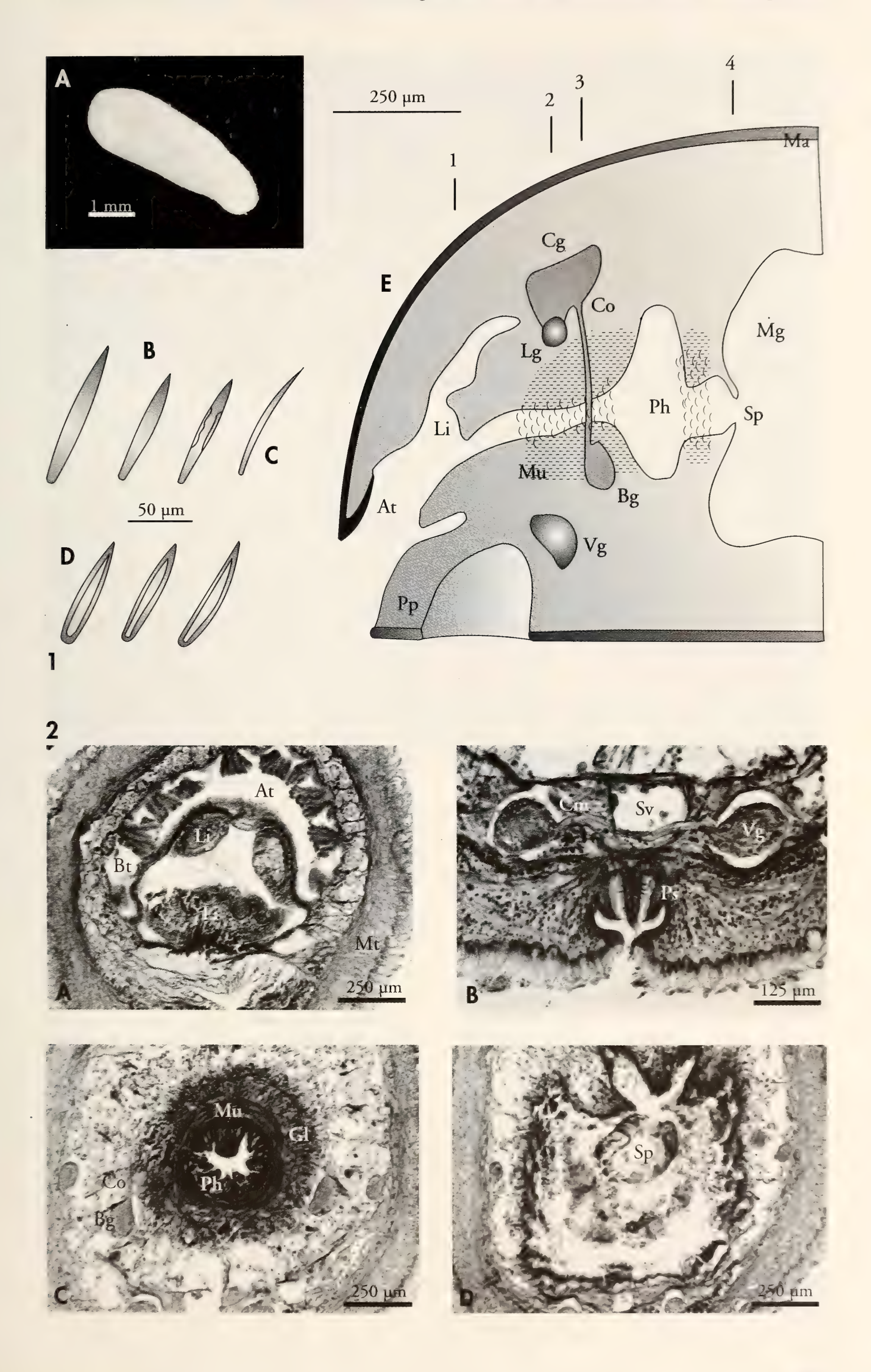
Rhopalomenia carinata Salvini-Plawen, 1978

Material examined: One specimen, 7 mm in length by 0.6 mm in width, (sectioned in 10 µm seriated cuts), was collected at station A-30 (62° 01′ 24″ S; 60° 26′ 16″ W) with a Assasiz trawl drag, on a muddy bottom at a depth of 710 m, off Livingston Island (South Shetland Islands, Antarctic) during the Spanish campaign, BENTART'95, to study the Antarctic benthos.

Description: The specimen studied was slightly flattened, laterally, in the anterior part, presenting a barely protruding dorsal cuticular keel, although this is visible in the transversal cuts (Figs. 3A-C). In alcohol the colour of the animal is light brown. Cuticle is not thick, up to 60 µm, attaining 90 µm in the keel. Sclerites are arranged in several layers within the cuticle, are hollow, straight or slightly arched aciculars in varying sizes, up to 100 µm in length, and are similar to those observed in the other species of the genus (see Fig. 151 in SALVINI-PLAWEN, 1978). Blade shaped solid scales, of up to 60 µm length, are found in the pedal groove. A single fold is presented in the pedal groove (Figs. 3D, E), which does not access the pallial cavity. The pallial cavity is small, presenting no respiratory folds, lacking abdominal spicules and copulatory spicules, the anus leading out dorsally in it, whereas the spawning duct does so ventrally. In the specimen studied, no presence of a sensitive dorsoterminal organ was noted. The mouth (Fig. 3B) opens separated from the atrium (Fig. 3C) and is located at the end of a short duct located within the buccal cavity. The radular sac in the mid part has a characteristic ventral epithelial fold (Fig. 3D). It presents a pair of ventral foregut glandular organs formed by two long ducts, which lead into supepithelial glandular follicles (type A according SALVINI-PLAWEN, 1978). Anteriorly, these ducts are located parallel to the end part of the radular sac until leading laterally into the same. These three ducts (the two glandular organs and the radular sac) are jointly surrounded by circular musculature (Figs. 3D,E). The oesophagus is very

(Right page) Figure 1. *Neomenia* sp. A: habitus; B: elongate laminate scales; C: acicular spicules; D: groove-shaped scales; E: Schematic organization of anterior body. At: atrium; Bg: buccal ganglion; Bt: buccal tube; Cg: cerebral ganglion; Cm: nervous commissure; Co: connective; Gl: glands; Lg: lateral ganglion; Li: lip; Ma: mantle; Mg: midgut; Mt: matrix; Mu: musculature; Ph: pharynx; Pp: pedal pit; Ps: pedal groove folds; Sp: sphincter; Sv: ventral blood sinus; Vg: ventral ganglion. 1-4 lines corresponding to cross-sections A-D in Figure 2. Figure 2. A-D. Microphotographs of the cross-sections of the anterior region of the body corresponding to lines 1-4 in Figure 1.

(Página derecha) Figura 1. Neomenia *sp. A: habitus; B: escamas laminares alargadas; C: espículas aciculares; D: escamas excavadas; E: organización esquemática de la parte anterior del cuerpo. At: atrio; Bg: ganglio bucal; Bt: tubo bucal; Cg: ganglio cerebral; Cm: comisura nerviosa; Co: conectivo; Gl: glándulas; Lg: ganglio lateral; Li: labio; Ma: manto; Mg: intestino; Mt: matríz; Mu: musculatura; Ph: faringe; Pp: fosa pedia; Ps: pliegues del surco pedio; Sp: esfínter; Sv: seno sanguíneo ventral; Vg: ganglio ventral. 1-4 líneas que corresponden a los cortes en sección A-D en la Figura. Figura 2. A-D. Microfotografías de los cortes en sección de la región anterior del cuerpo correspondientes a las líneas 1-4 de la Figura 1.*


A
1 mm
B
C
50 µm
D
1
250 µm
1
2
3
4
E
Ma
Cg
Co
Mg
Lg
Ph
Sp
Li
Mu
Bg
At
Vg
Pp
2
At
Li
Bt
Mt
250 µm
A
Sv
Vg
125 µm
B
Mu
Gl
Co
Ph
Bg
250 µm
C
Sp
250 µm
D

long and is located dorsally to the radular sac and to the ventral foregut glandular organs until leading into the midgut. The midgut has a large dorso-rostral caecum, which reaches the level of the cerebral ganglion (Figs. 3B-D). The gonad is full of spermatozoids and ovules, and has a pair of dorsal seminal receptacles at the spawning ducts.

Remarks: The specimen studied is from a geographical area (Livingston Island, South Shetland Islands) close to part of the material studied in the original description (Elephant Island/ Joinville Island, South Shetland Islands), although at a considerably greater depth 710 m, as opposed to 119-220 m (SALVINI-PLAWEN, 1978). It presents a thinner cuticle than the model material, 60 µm in the present specimen 7 mm in length by 150-225 µm for specimen up to 35 mm; no pedal fold was observed within the pallial cavity, nor was there the presence of a dorsoterminal sensitive organ, as noted in the original description. But other important features particular to this species are well defined: the mouth is located at the end of a horn and separate from the atrium; the ventral glandular organs of the pharynx are subepithelial, and the anterior tubular part with the radular sac are jointly surrounded by circular musculature; it presents a ventral epithelial fold in the mid part of the radular sac; and the general structure of the gonopericardic system is similar.

Rhopalomenia rhynchopharyngeata Salvini-Plawen, 1978

Material examined: One specimen 13 mm in length and 2.1 mm in width (sectioned into 10 µm seriated cuts), collected at station A-19 (62º43′43″S; 60º31′27″W) with an Agassiz drag trawl on a muddy bottom at a depth of 235 m, off Livingston Island (South Shetland Islands, Antarctic) during the Spanish campaign, BENTART'95, for the study of the Antarctic benthos.

Description: Rolled up animal with no keel or protuberances (Fig. 4A), cylindrical in section, with a bristling appearance due to the sclerites standing out from the mantle. In alcohol the colour of the animal is light brown. Thick cuticle of up to 150 µm. The sclerites are arranged in several layers, both obliquely and radially on the cuticle, with different sized hollow, straight or slightly arched acicules, similar to those appearing in other species of the genus (see Figure 151 in SALVINI-PLAWEN, 1978), attaining maximum lengths of 200 µm. Blade shaped solid scales are found in the pedal groove of up to 80 µm in length. In the first third of the body, the pedal groove presents three folds, a longer central one of up to 120 µm, and two shorter lateral folds of up to 70 µm. In the posterior part only one fold is found, which does not access the pallial cavity (Figs. 4C-E). The pallial cavity is small, without respiratory folds, lacking abdominal spicules and copulatory spicules (Fig. 4B), and the anus open dorsally into the cavity. The spawning duct opens independently of the pallial cavity, since it ends unpaired, free and directly outside the cavity on the ventral part (Fig. 4B). There is a dorsoterminal sensitive organ located at the posterior end of the body. The mouth opens separated from the atrium. It lacks a radula but presents a short radular sac. The ventral foregut glandular organs are formed by two long ducts into which subepithelial glandular follicles open (Type A according to Salvini-Plawen, 1978). Anteriorly, these ducts are located freely to both sides of the radular sac, until they open laterally into the radular sac, and are not jointly surrounded to the radular sac by a common circular musculature. The oesophagus is very long, and open into the ventral part of the midgut. The midgut has a dorso-rostral caecum, which extends to the level of the cerebral ganglion. The rectum (Figs. 4C,D,E) is circular in section (diameter up to 150 µm). The gonad is full of spermatozoids and ovules. The pericardium is not very voluminous and is circular in section



Figure 3. *Rhopalomenia carinata* Salvini-Plawen, 1978. A: habitus; B-E: microphotographs of the cross-sections of the anterior region of the body. At: atrium; Bo: buccal opening; Cg: cerebral ganglion; Dc: dorsal caecum; Fd: ventral epithelial fold of the radular sac; Ke: keel; Lg: lateral ganglion; Mu: circular musculature; Ph: pharynx; Rs: radular sac; Vfg: ventral foregut glandular organ.
Figure 3. Rhopalomenia carinata *Salvini-Plawen, 1978. A: habitus; B-E: microfotografías de los cortes en sección de la región anterior del cuerpo. At: atrio; Bo: abertura bucal; Cg: ganglio cerebral; Dc: ciego dorsal; Fd: pliegue epitelial ventral del saco radular; Ke: cresta; Lg: ganglio lateral; Mu: musculatura circular; Ph: faringe; Rs: saco radular; Vfg: órgano glandular ventral de la faringe.*

(diameter of 200-250 µm), the heart is located dorsally in the pericardium, is relatively large and perfectly bilobulated (Fig. 4E). There is a pair of seminal receptacles lying dorsal to the spawning ducts (Fig. 4F). The spawning ducts (Figs. 4C-F) are circular in section (up to 400 µm in diameter), and with their glandular walls, in the posterior part fuse into a single duct (Fig. 4E), also circular in section (up to 450 µm in diameter) and with glandular walls.

Remarks: The specimen studied here is from a geographical area (Livingston Island, South Shetland Islands) close to part of the material studied in the original description (Elephant Island/ Joinville Island, South Shetland Islands) and at a similar depth (SALVINI-PLAWEN, 1978). This specimen is of a larger size (13 mm x 2.1 mm) than those studied in the original description (10 mm x 1 mm); the cuticle is thicker, 150 µm as opposed to 120 µm, the same occurring with the

length of the folds in the pedal groove, where the central groove attains 120 µm and the lateral grooves 70 µm, as opposed to 85 µm and 60 µm in the model specimen. The gonad is not observed as being divided into two by a septum, as indicated in the original description. The characteristics of this species are well defined (see Table 4, p. 159, in SALVINI-PLAWEN, 1978): the specimen presents a bristly appearance due to the radially arranged sclerites; the spawning duct open directly into the pallial cavity; no radula; the radular sac is short; and the anterior parts of the ventral foregut glandular organs are located laterally to the radular sac, without circular musculature surrounding the three ducts.

Family PRONEOMENIIDAE Simroth, 1893
Genus *Dorymenia* Heath, 1911

Dorymenia parvidentata sp. nov.

Type material: Holotype measuring 7.0 mm in length, 0.6 mm in width (spicule slide, specimen in seriated sections).
Type locality: Livingston Island (station A-7, BENTART'95) (South Shetland Islands, Antarctic) 62º44'07"S, 60º27'42"W from a silt bottom at 80 m depth.
Deposit and derivatio nominis: The holotype is deposited in the "Museo Nacional de Ciencias Naturales" of Madrid, number: MNCN 15.02/12. The specific name refers to the few radular teeth it has (from the Latin: *parvum*: small amount; *dens*: tooth).

Diagnosis: Body 7.0 x 0.6 mm, in rounded section, with no keel or protuberances. Not thick cuticle (50 µm). With hollow acicular sclerites. Radula with 10-12 short based teeth with a pointed, slightly curved apex. Pallial cavity with walls with no diverticles, extending anteriorly into a ventral sac. Unpaired spawning duct leading into the dorsal wall of the pallial cavity. A pair of four pointed copulatory spicules star shaped in section. Without abdominal spicules. Elongated erythrocytes with no granulations. With a dorsoterminal sensitive organ.

Description: Animal with an elongated, cylindrically shaped body, with no protuberances or keel (Fig. 5A). Smooth mantle surface, with no projecting sclerites and a visible ventral groove. In alcohol the colour of the animal is light brown. Cuticle is not thick, measuring about 55 µm, with hollow, slightly arched acicular sclerites of up to 180 µm in length (Fig. 5C) arranged in layers. Along the pedal groove there are two further types of sclerites: solid, slightly curved acicular spicules of up to 160 µm, with one of its two ends pointed and other rounded (Fig. 5D) and blade shaped scales of up to 110 µm in length (Fig. 5E). The pedal groove starts in a small pedal pit (Fig. 5F) and presents a single fold (Fig. 6D), which does not access the pallial cavity. The pallial cavity opens onto the exterior by a narrow ventro-posterior opening, and presents no respiratory folds or diverticles in its walls (Fig. 6F). It has a pair of copulatory spicules, in section star-shaped with four pointes, arranged ventrolaterally on some small protuberances in the walls of the pallial cavity (Figs. 5G, 6E). It lacks abdominal spicules. The anus opens out into the dorsal wall of the pallial cavity (Fig. 5G). The pallial cavity presents an ample sac, which extends ventro-anteriorly below the pericardioducts and the rectum (Figs. 5G, 6E). The atrial sensitive organ presents several simple papilla on its walls, and dorsally to this organ lies the cerebral ganglion (Figs. 5F, 6A), the only part of the nervous system to be observable in this specimen. It has a single dorsoterminal sensitive organ (Fig. 5G). The mouth opens into the atrial cavity, occupying a dorsoposterior position, and is located at the end of duct, which in the case of the specimen studied, was found to be evaginated (Figs. 5F, 6B). The pharynx is short and in the midgut pre-

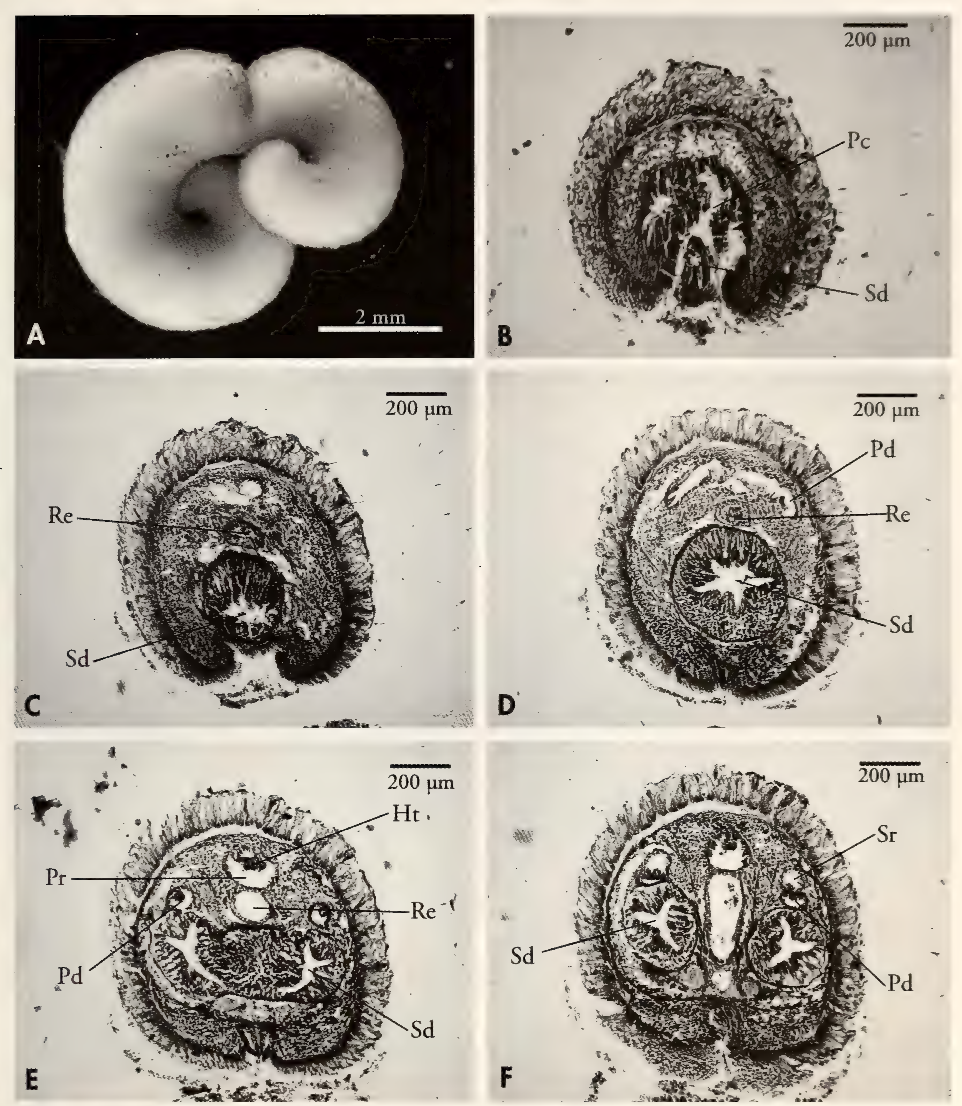


Figure 4. *Rhopalomenia rhynchopharyngeata* Salvini-Plawen, 1978. A: habitus; B-F: microphotographs of the cross-sections of the posterior region of the body. Ht: heart; Pc: pallial cavity; Pd: pericardioduct; Pr: pericardium; Re: rectum; Sd: spawning duct; Sr: seminal receptacle.
Figure 4. Rhopalomenia rhynchopharyngeata *Salvini-Plawen, 1978. A: habitus; B-F: microfotografías de los cortes en sección de la región posterior del cuerpo. Ht: corazón; Pc: cavidad paleal; Pd: pericardioducto; Pr: pericardio; Re: recto; Sd: conducto de desove; Sr: receptáculo seminal.*

sents a very short dorso-rostral caecum (Figs. 5F, 6B). It has a short radular sac, and a polystichous/polyseriate radula, consisting of 10-12 teeth measuring 20-25 µm length, with a short base and elongated, slightly curved apex (Fig. 5B). Teeth are located isolated upon a basal membrane. The pair of ventral foregut glandular organs (Figs. 5F, 6C) are epithelial and tubular shaped (Type C, according to Salvini-Plawen, 1978), leading laterally into the anterior part of the

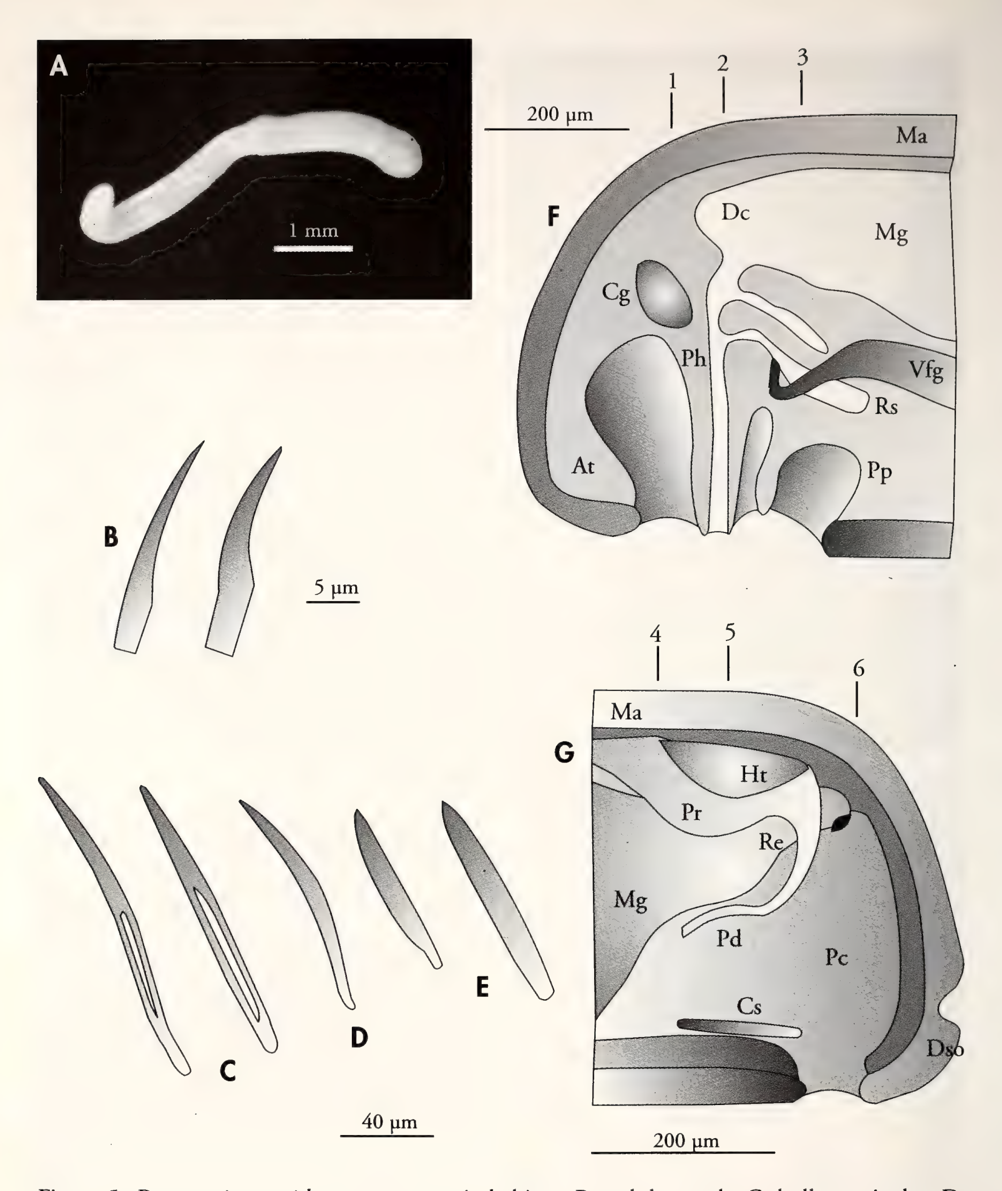


Figure 5. *Dorymenia parvidentata* sp. nov. A: habitus; B: radular teeth; C: hollow spicules; D: groove solid spicules; E: groove scales; F: schematic organization of anterior body; G: Schematic organization of posterior body. At: atrium; Cg: cerebral ganglion; Cs: copulatory spicule; Dc: dorsal caecum; Dso: dorsoterminal sense organ; Ht: heart; Ma: mantle; Mg: midgut; Pc: pallial cavity; Pd: pericardioduct; Ph: pharynx; Pp: pedal pit; Pr: pericardium; Re: rectum; Rs: radular sac; Vfg: ventral foregut glandular organ. 1-6 lines corresponding to cross-sections A-F in Figure 6.
Figura 5. Dorymenia parvidentata *sp. nov. A: habitus; B: dientes radulares; C: espículas huecas; D: espícula maciza del surco pedio; E: escamas del surco pedio; F: organización esquemática de la parte anterior del cuerpo; G: organización esquemática de la parte posterior del cuerpo. At: atrio; Cg: ganglio cerebral; Cs: espídula copuladora; Dc: ciego dorsal; Dso: órgano sensitivo dorsoterminal; Ht: corazón; Ma: manto; Mg: intestino; Pc: cavidad paleal; Pd: pericardioducto; Ph: faringe; Pp: fosa pedia; Pr: pericardio; Re: recto; Rs: saco radular; Vfg: órgano glandular ventral de la faringe. 1-6 lineas que correspondes a los cortes en sección A-F en la Figura 6.*

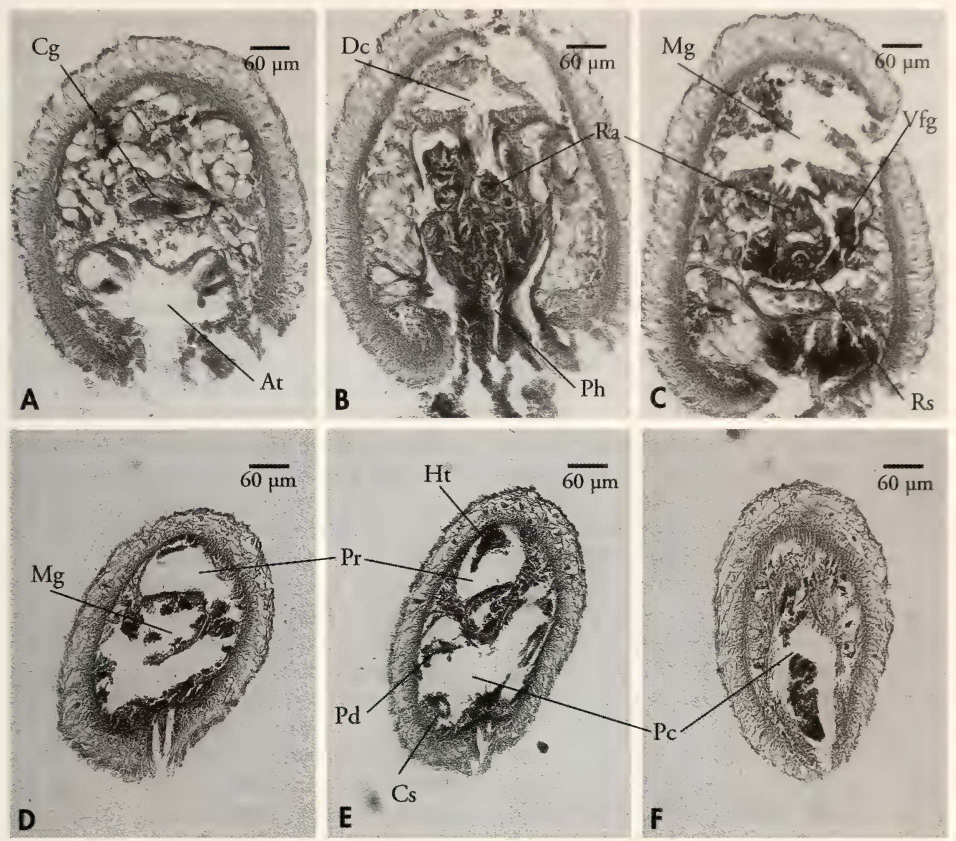


Figure 6. *Dorymenia parvidentata* sp. nov. A,B,C: microphotographs of the cross-sections of the anterior region of the body corresponding to lines 1,2,3 in Figure 5. D,E,F: microphotographs of the cross-sections of the posterior region of the body corresponding to lines 4,5,6 in Figure 3. At: atrium; Cg: cerebral ganglion; Cs: copulatory spicule; Dc: dorsal caecum; Ht: heart; Mg: midgut; Pc: pallial cavity; Pd: pericardioduct; Ph: pharynx; Pr: pericardium; Ra: radula; Rs: radular sac; Vfg: ventral foregut glandular organ.

Figure 6. Dorymenia parvidentata *sp. nov. A,B,C: microfotografías de los cortes en sección de la región anterior del cuerpo correspondientes a las líneas 1,2,3 de la Figura 5. D,E,F: microfotografías de los cortes en sección de la región posterior del cuerpo correspondientes a las líneas 4,5,6 de la Figura 5. At: atrio; Cg: ganglio cerebral; Cs: espícula copuladora; Dc: ciego dorsal; Ht: corazón; Mg: intestino; Pc: cavidad paleal; Pd: pericardioducto; Ph: faringe; Pr: pericardio; Ra: rádula; Rs: saco radular; Vfg: órgano glandular ventral de la faringe.*

radular sac, and are located ventrally under the first third of the midgut. The erythrocytes are elongated (15 µm length) and present no granulations. The heart is clearly bilobulated ventrally (Fig. 6E), and is located inside a large pericardium. The pair of pericardioducts lead out from the pericardium on the posterior-lateral part, and are laocated ventrolaterally to the digestive duct. The exemplar was immature, no ovules or spermatozoids were observed in the gonads, the periocardioducts can be observed as narrow ducts until they vanish, no spawning duct is present (Figs. 5G, 6E) and no seminal receptacles or the anterior part of the reproductive apparatus were noted.

DISCUSSION

Neomenia sp. belongs to the order Neomeniamorpha, as it presents solid acicular sclerites together with groove-shaped scales; there are no ventral glandular organs in the pharynx; with respiratory folds, and it is assigned to the family Neomeniidae, as it has a relatively thick cuticle with epithelial papillae and subepithelial matrix, solid acicular sclerites and elongated groove-shaped scales, it lacks a radula and has a pedal groove with several folds (SALVINI-PLAWEN, 1978).

At present two genera of the family Neomeniidae are known: *Neomenia* Tullberg, 1875 and *Heathimenia* Salvini-Plawen, 1967. The specimen is assigned to the genus *Neomenia* as it fulfils the main characteristics of the genus: a somewhat thick cuticle with papillae; solid, grooved sclerites; buccal opening in the atrium; absence of a radula and ventral glandular organs in the pharynx; midgut with lateral constrictions and the presence of respirators folds (WIREN, 1892; SALVINI-PLAWEN, 1978). The status of the genus *Heathimenia* with *H. verrilli*, collected in the Gulf of Saint Lawrence on the east coast of North America (HEATH, 1918) is not settled and the species needs re-examination (SALVINI-PLAWEN, 1967, 1978).

Currently six Antarctic or Sub-Antarctic species are known to belong to the genus *Neomenia*. *N. permagna* Salvini-Plawen, 1978 is a South Pacific species collected at a depth of 549 m. The following characteristics distinguish it from *Neomenia* sp.: the body size (12 cm x 3 cm); the presence of only groove-shaped scales and solid acicular sclerites; a pedal groove having 25 folds; a rostral tube-like pharynx, without a terminal sphincter. *N. labrosa* Salvini-Plawen, 1978 was collected on the South Shetland Islands (Elephant Island) at a depth of 220-240 m. It is differentiated from *Neomenia* sp. by the following features: the presence of only groove-shaped scales and solid acicular sclerites; a pedal groove having 13-1 folds; a pharynx with a lateral slit at each side in the rostral portion which separates the dorsal and ventral lips, without a terminal sphincter. *N. trapeziformis* Salvini-Plawen, 1978 is a South Pacific species that was collected on the Antipode Islands at a depth of 2010-2110 m (SALVINI-PLAWEN, 1978).

The main characteristics distinguishing it from *Neomenia* sp. are: a body with strong lateral edges and an even number or dorsal lumps that give it its shape in the typical trapezoidal section; the presence of only groove-shaped scales; arrowhead-shaped sclerites and solid acicular sclerites; a pedal groove having 23-3 folds; a pharynx with a short lateral slit at each side in the rostral portion, separating the dorsal and ventral lips; the ventral lip is not separated from the wall of the buccal cavity. *N. crenagulata* Salvini-Plawen, 1978 is a South Indian species, collected from the Kerguelen Islands at 585 m. The characteristics that separate it from *Neomenia* sp. are: the presence of only groove-shaped scales and solid acicular sclerites; a pedal groove having 13-1 folds, a pharynx with a ventral slit in the rostral portion; the dorsal wall of the pharynx has pronounced folds that hang over the buccal space. *N. laminata* Salvini-Plawen, 1978 was collected from the South Orkney Islands at a depth of 298-302 m. The main traits serving to differentiate it from *Neomenia* sp. are: a pedal groove with 7-3 folds; a pharynx without slits to delimit the lips. *N. propietecta* Salvini-Plawen, 1978 was collected from the Ross Sea near Victoria Land at a depth of 344-351 m. The characteristics separating it from *Neomenia* sp. are: the presence of only groove-shaped scales and acicular sclerites with keels; a pedal groove with one fold; a pharynx without slits to delimit the lips.

Due to the considerable damage of the posterior body, it was only possible to study and reconstruct the anterior part of the single specimen available. The differences between *Neomenia* sp. and other species of this genus are quite clear, especially owing to the presence of the three large lips in the rostral portion of the pharynx, the elongated laminate mantle scales, as well as its geographical

location. But as its important posterior organs are unknown, it is not described as a new species until it is confirmed with new data.

Dorymenia parvidentata sp. nov. belongs to the order Cavibelonia, as it presents hollow acicular sclerites ordered into several layers within a relatively thick cuticle, and is classified in the family Proneomeniidae based on the fact that it has a polystic/polyseriated radula and tubular epithelial ventral foregut glandular organs of type C (Salvini-Plawen, 1978). The characteristics which locate this new species within the genus *Dorymenia* are well defined: the mouth opens into the atrium; the genital orifice is impair, it presents a dorsoterminal sensitive organ, has copulatory spicules and the pallial cavity presents no respiratory folds.

Taking into account the radular structure and teeth form (Salvini-Plawen, 1978; García-Álvarez *et al.*, 2000), the species of the genus *Dorymenia* may be classified into three general groups: one group presenting numerous short radular teeth with a curved apex and long base; another group with short based teeth and one or two medium sized teeth; and a third group, which includes *Dorymenia parvidentata* sp. nov., characterised by presenting a radula with few, very elongated and short based apex teeth, constituting: *Dorymenia acutidentata* Salvini-Plawen, 1978; *Dorymenia paucidentata* Salvini-Plawen, 1978 and *Dorymenia singulatidentata* Salvini-Plawen, 1978.

With each of the three species cited above, *Dorymenia parvidentata* sp. nov. presents significant differences (see Table 1 in García-Álvarez *et al.*, 2000). *Dorymenia parvidentata* sp. nov. presents 10-12 radular teeth, whereas *D. acutidentata* has 22-26, *D. paucidentata* 12-14 and *D. singulatidentata* 14. The pallial cavities are very different, *Dorymenia parvidentata* sp. nov. presents no diverticles and extends anteriorly in a ventral sac, whereas in *D. actuidentata* it has numerous diverticles and a dorsoanterior sac, in *D. paucidentata* lacks diverticles and presents a pair of lateral sacs and a pair of ventroanterior sacs and in *D. singulatidentata* lacks diverticles and presents a pair of ventroanterior sacs. Also, sectioning of the copulatory spicules in *D. acutidentata* and *D. singulatidentata* reveals a circular formation and not a four-pointed star as in *Dorymenia parvidentata* n. sp. Finally, in *D. acutidentata* the pedal fold enters the pallial cavity, whereas this is not the case in *Dorymenia parvidentata* sp. nov.

ACKNOWLEDGEMENTS

We thank Dr. Luitfrid v. Salvini-Plawen of the University of Vienna for his assistance. This work was supported by the BENTART projets (ANT94-1161-E, ANT95-1011; ANT97-2097-E) and the Integrated Spanish-Austrian Co-operation Actions (HU1997-0002; HU2000-0010). Thanks also to Ian Emmett for the English translation.

BIBLIOGRAPHY

García-Álvarez, O. and Urgorri, V. 2003. *Ocheyoherpia bursata* a new species of Phyllomeniidae (Mollusca, Solenogastres: Sterrofustia) from the South Shetland Islands (Antarctica). *Journal of Molluscna Studies* (en prensa)

García-Álvarez, O., Urgorri, V. and Salvini-Plawen, L.v., 1998. *Dorymenia troncosoi* sp. nov. (Mollusca Solenogastres: Proneomeniidae), a new species from the South Shetland Islands (Antarctica). *Polar Biol*, 20: 382-387.

García-Álvarez, O., Urgorri, V. and Salvini-Plawen, L.v., 2000. Two new species of *Dorymenia* (Mollusca: Solenogastres: Proneomeniidae) from the South Shetland Islands (Antarctica). *Journal of the Marine Biological Association of the United Kingdom*, 80: 835-842.

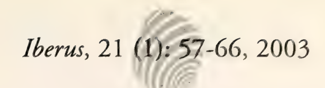
Heath H 1918. Solenogastres from the Eastern Coast of North America. *Memoirs of the Museum of Comparative Zoology at Harvard College*, 45 (2): 183-263.

SALVINI-PLAWEN, L.V., 1967. Kritische Bermerkungen zum System der Solenogastres. *Zeitschrift für zoologische Systematik und Evolutionsforschung*, 5 (4): 419-437.

SALVINI-PLAWEN, L.V., 1978. Antarktische und subantarktische Solenogastres. Eine Monographie : 1898-1974. *Zoologica (Stuttgart)*, 128 : 1-315.

WIREN. A., 1892. Studien über Solenogastres II. Kunglige *Svenska Vetenskaps- Akademiens Handlingar*, 25 (6): 1-100.

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Cephalopod species collected in the upper continental slope off Alicante (Western Mediterranean)

Especies de cefalópodos capturadas en el talud superior de Alicante (Mediterráneo occidental)

Sergi SORIANO*[1], José L. SÁNCHEZ LIZASO* and Angel GUERRA**

Recibido el 4-VII-2002. Aceptado el 29-X-2002

ABSTRACT

The cephalopod fauna collected in 24 hauls carried out in the upper continental slope off Alicante (Western Mediterranean) by commercial trawlers is analysed. Samples were taken at depths between 237 and 611 m from April 1998 to December 1999. Eighteen species in 8 families were captured. *Todarodes sagittatus, Todaropsis eblanae, Rossia macrosoma, Sepietta oweniana, Eledone cirrhosa* and *Octopus salutii* were the most abundant species. Cephalopods represented 3.9 % of the total catch (94 kg). Average cephalopod biomass estimated was 89.2 g/hectare. The known depth range for *Octopus defilippi* in the Mediterranean is expanded up to 370 m. Observed seasonal changes in biomass of main species are discussed.

RESUMEN

En el presente trabajo se analizan los cefalópodos capturados por arrastreros comerciales en 24 lances realizados en el talud superior de la provincia de Alicante (Mediterráneo occidental). Las muestras fueron tomadas entre los 237 y 611 m de profundidad, entre abril de 1998 y diciembre de 1999. Se capturaron 18 especies pertenecientes a 8 familias. *Todarodes sagittatus, Todaropsis eblanae, Rossia macrosoma, Sepietta oweniana, Eledone cirrhosa* y *Octopus salutii* fueron las más abundantes. Los cefalópodos representaron un 3,9 % de la captura total (94 kg.). La biomasa de cefalópodos media estimada fue de 89,2 gr./hectárea. El rango de profundidad conocido para *Octopus defilippi* en el Mediterráneo fue ampliado hasta los 370 metros. Se discuten los cambios estacionales de biomasa de las especies más importantes.

KEY WORDS: Cephalopods; Trawl fishery; Seasonality; By-catch; Western Mediterranean.
PALABRAS CLAVE: Cefalópodos, Pesquería de Arrastre, Estacionalidad, Pesca Acompañante, Mediterráneo occidental.

INTRODUCTION

An important trawling fishery is conducted in the upper continental slope off Alicante (Western Mediterranean). The main target species of this fishery are

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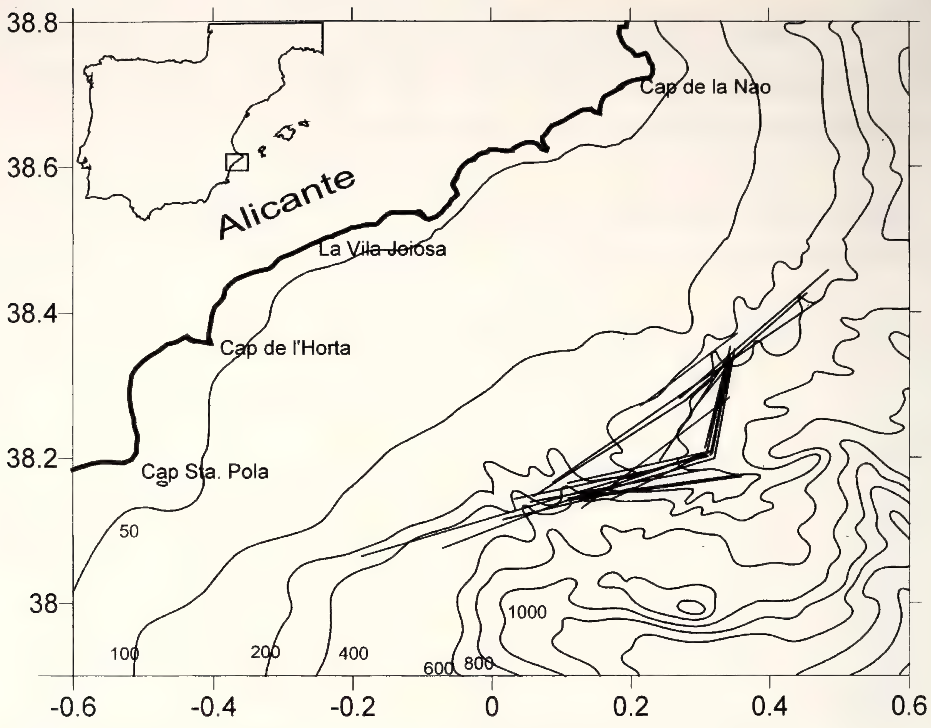


Figure 1. Location of samples in the study area. Lines link initial and final sampling positions.
Figura 1. Localización de las muestras en el área de estudio. Las líneas unen las posiciones iniciales y finales del muestreo.

Norway lobster (*Nephrops norvegicus*), rose shrimp (*Aristeus antennatus*), *Plesionika* spp., European hake (*Merluccius merluccius*), blue whiting (*Micromesistius poutassou*) and great fork-beard (*Phycis blennoides*). Cephalopods are not target species but contribute to by-catch (SORIANO, 2000).

Faunistic composition and spatial distribution of the cephalopods in the Spanish Mediterranean waters is relatively well known (see GUERRA, 1992 for a review). However, this information mainly corresponds to the Catalan Sea (41° N to 43° N). Thus, the results of cluster analysis in this area, as well as in the northern Tyrrhenian Sea, showed the presence of clear associations related with depth (SÁNCHEZ, BELCARI AND SARTOR, 1998). Cephalopod assemblages and some biological aspects of deep-sea cephalopods species were studied in the continental shelf and upper slope off Balearic Islands (QUETGLAS, ALEMANY AND SÁNCHEZ, 2000). On the other hand, different seasonal abundances were found in the bathymetric distribution of some species in the Catalan Sea that could be related to differences in the spawning and/or recruitment periods for each species (SÁNCHEZ, 1986; SÁNCHEZ *ET AL.*, 1998). Depth ranges recorded for 10 species from the bathyal basin (1000-2000 m depth) of the North-Western Mediterranean were analysed and discussed by VILLANUEVA (1992), who suggested an up-slope ontogenic migration of *Bathypolypus sponsalis* and *Neorossia caroli*. Furthermore, the distribution and abundance of bathyal sepiolids in this area has notably increased as stated by VILLANUEVA (1995).

The results obtained by SARTOR, BELCARI, CARBONELL, GONZÁLEZ, QUET-

Table I. Data summary on trawling operations
Tabla I. Resumen de los datos de las operaciones de pesca.

Haul	Date	Initial position	Final Position	Min Depth	Max Depth	Surface (km2)	Total catch (kg)	Ceph catch (kg)
1	14/04/1998	38-28-645N / 0-32-266E	38-11-052N / 0-13-704E	333	522	0.896	210.5	3.8
2	10/07/1998	38-18-942N / 0-20-236E	38-10-771N / 0-19-096E	433	444	0.285	69.5	6.3
3	10/07/1998	38-09-195N / 0-21-305E	38-07-122N / 0-06-325E	602	602	0.530	70.6	1.2
4	17/07/1998	38-18-942N / 0-20-236E	38-10-771N / 0-19-096E	433	444	0.285	41.7	1.9
5	17/07/1998	38-09-500N / 0-12-384E	38-10-761N / 0-17-889E	426	500	0.183	41.0	7.7
6	21/08/1998	38-19-349N / 0-20-432E	38-10-621N / 0-19-119E	444	444	0.285	96.3	1.2
7	21/08/1998	38-10-693N / 0-17-879E	38-07-177N / 0-10-024E	426	426	0.611	268.9	1.0
8	04/09/1998	38-19-830N / 0-20-375E	38-11-671N / 0-18-255E	407	463	0.346	177.2	4.2
9	04/09/1998	38-10-701N / 0-17-889E	38-07-524N / 0-07-347E	389	426	0.530	141.7	3.7
10	16/10/1998	38-02-764N / 0-04-881W	38-07-692N / 0-07-625E	611	611	0.407	38.4	1.1
11	16/10/1998	38-07-328N / 0-03-068E	38-11-094N / 0-15-578E	351	444	0.469	68.5	2.4
12	23/10/1998	38-19-262N / 0-20-377E	38-10-649N / 0-19-090E	407	433	0.318	57.6	1.8
13	23/10/1998	38-14-639N / 0-16-871E	38-18-838N / 0-20-721E	388	426	0.570	169.3	3.5
14	13/11/1998	38-05-303N / 0-00-374E	38-08-106N / 0-11-955E	574	611	0.367	16.7	0.7
15	13/11/1998	38-09-829N / 0-14-004E	38-07-143N / 0-01-413E	420	426	0.489	92.1	2.6
16	07/12/1998	38-10-701N / 0-17-889E	38-02-090N / 0-11-960W	444	454	0.937	89.2	4.2
17	12/03/1999	38-21-907N / 0-21-092E	38-15-411N / 0-12-516E	237	244	0.367	97.8	6.2
18	12/03/1999	38-16-044N / 0-15-958E	38-27-538N / 0-29-082E	366	377	0.652	170.8	7.3
19	18/03/1999	38-19-544N / 0-20-219E	38-10-594N / 0-14-243E	366	407	0.407	93.7	4.5
20	18/03/1999	38-15-978N / 0-16-526E	38-25-409N / 0-27-173E	352	370	0.566	132.9	4.4
21	23/04/1999	38-06-891N / 0-02-817E	38-09-785N / 0-18-263E	504	509	0.469	115.2	4.7
22	23/04/1999	38-10-535N / 0-18-540E	38-08-542N / 0-06-104E	426	444	0.530	85.9	3.9
23	04/06/1999	38-25-010N / 0-28-575E	38-08-627N / 0-04-798E	444	474	0.947	193.1	9.4
24	27/12/1999	38-19-693N / 0-20-497E	38-07-000N / 0-04-545W	426	370	0.926	473.8	6.1

GLAS AND SÁNCHEZ (1998) showed that few cephalopods are discarded from trawlers operating in the Western Mediterranean. Although discarding of cephalopod was practically negligible in terms of biomass in all-bathymetric strata analysed by the authors, in terms of number of species the discard component was, however, notable.

In Alicante and VALENCIA REGION, SÁNCHEZ AND OBARTI (1993) studied the biology and fishery of *Octopus vulgaris* and BLANCO, AZNAR AND RAGA (1995) analysed the cephalopod composition in the diet of the striped dolphin *Stenella coeruleoalba*. Despite this, little is known about the upper slope continental cephalopods from the Central Spanish Mediterranean Sea. Although GUERRA (1992) reported some species from this area, the cephalopod fauna of this region have not received especial attention. It is therefore important to determine what cephalopod species capture the trawling fishery operating off Alicante, which is one of the most important fishing areas of the Western Mediterranean (OLIVER, 1983). This paper provides a list of the cephalopod species caught during a project carried out with the objective of analysing the discards of the upper continental slope off Alicante, as well as some information on the bathymetric distribution and seasonal changes in the main cephalopod species abundance.

Table II. List of species collected in this paper after SWEENEY AND ROPER (1998).
Tabla II. Lista de especies obtenidas en el presente estudio según SWEENEY Y ROPER (1998).

Class *Cephalopoda* Schneider, 1784
- Order *Sepiida* Zittel, 1895
  - Family *Sepiidae* Keferstein, 1866
    - *Rhombosepion orbignyana* (Férussac, 1826)
- Order *Sepiolida* Grimpe, 1921
  - Family *Sepiolidae* Leach, 1817
    - Subfamily *Rossinae* Appellöf, 1898
      - *Rossia macrosoma* (Delle Chiaje, 1830)
      - *Neorossia caroli* (Joubin, 1902)
    - Subfamily *Sepiolinae* Appellöf, 1898
      - *Sepietta oweniana* (Orbigny, 1840)
- Order *Teuthida* Naef, 1916
  - Family *Loliginidae* Lesueur, 1821
    - *Loligo media* (Linnaeus, 1758)
  - Family *Enoploteuthidae* Pfeffer, 1900
    - *Abralia veranyi* (Rüppell, 1844)
  - Family *Onychoteuthidae* Gray, 1849
    - *Onychoteuthis* sp.
  - Family *Histioteuthidae* Verill, 1881
    - *Histioteuthis bonnellii* (Férussac, 1834)
    - *Histioteuthis reversa* (Verrill, 1880)
  - Family *Ommastrephidae* Steenstrup, 1857
    - Subfamily *Illicinae* Posselt, 1891
      - *Illex coindetii* (Vérany, 1839)
    - Subfamily *Todarodinae* Adam, 1960
      - *Todaropsis eblanae* (Ball, 1841)
      - *Todarodes sagittatus* (Lamarck, 1798)
- Order *Octopoda* Leach, 1818
  - Family *Octopodidae* Orbigny, 1840
    - Subfamily *Octopodinae* Grimpe, 1921
      - *Octopus salutii* Vérany, 1836
      - *Octopus defilippi* Vérany, 1851
      - *Scaeurgus unicirrhus* (Delle Chiaje, 1840)
      - *Pteroctopus tetracirrhus* (Delle Chiaje, 1830)
    - Subfamily *Eledonidae* Grimpe, 1921
      - *Eledone cirrhosa* (Lamarck, 1798)
    - Subfamily *Bathypolypodinae* Robson, 1928
      - *Bathypolypus sponsalis* (Fischer and Fischer, 1892)

MATERIAL AND METHODS

During the April 1998-December 1999 period, twenty four individual samples were collected on board two commercial trawlers at a number of sampling locations at the same fishing ground on the upper continental slope off Alicante. The studied area is situated between 38° 13′ N//0° 32′ E and 37° 54′ N//0° 6′ W (Fig. 1). Initial and final tow position, tow duration and initial and final depths were registered on board. Depth range varied between 237 and 611 m. Hauls were carried out during daytime. Mean tow duration was 4.2 h and towing speed was 2.5 knots. Effective

Table III. Mean abundances (± SE) expressed in g/hectare and ocurrences (in %) of the species of cephalopods caught.
Tabla III. Abundacias medias (± ES) expresado en g/hectárea y ocurrencias (en %) de las especies de cefalópodos capturadas.

SPECIES	Abundance (* SE)	Ocurrence
Rhombosepion orbignyana	0.40 * 0.34	8.70
Rossia macrosoma	9.18 * 2.55	69.57
Neorossia caroli	0.14 * 0.14	4,.35
Sepietta oweniana	4.00 * 1.24	73.91
Loligo media	0.09 * 0.07	13.04
Abralia veranyi	0.03 * 0.02	17.39
Onychoteuthidae	0.01 * 0.01	4.35
Histioteuthis bonnellii	1.39 * 1.39	4.35
Histioteuthis reversa	0.74 * 0.51	13.04
Illex coindetii	2.87 * 1.51	21.74
Todaropsis eblanae	6.63 * 2.31	47.83
Todarodes sagittatus	30.06 * 4.90	86.96
Octopus salutii	5.97 * 2.27	52.17
Octopus defilippi	0.45 * 0.45	4.35
Scaergus unicirrhus	0.80 * 0.80	4.35
Pteroctopus tetracirrhus	1.02 * 0.49	21.74
Eledone cirrhosa	25.19 * 16.37	26.09
Bathypolypus sponsalis	0.26 * 0.20	8.70

gear opening width was 22 m. The surface sampled during each tow was estimated using tow duration, towing speed and gear opening.

Commercial individuals were identified and weighed on board using a dynamometer. A random subsample of the discarded fraction of the total catch in each haul was taken. These subsamples were transported fresh to the laboratory. Cephalopod individuals in these subsamples were sorted, identified and weighed to the nearest 0.1 g and the results were extrapolated to the total amount of discards. Then, the individuals were fixed in 10% formaline and preserved in 70% alcohol. Finally, the abundance of each cephalopod species was estimated and expressed as grams per hectare.

RESULTS

Table I shows a summary of information on trawling operations. A total of 93.7 kg of cephalopods were captured. Cephalopods represented 3.86% in weight of the total catch. The mean biomass of cephalopod estimated was 89.2 g/hectare.

The cephalopods collected comprised 18 species in 8 families (Table II). One individual of the family *Onychoteuthidae* was caught but its stage of conservation did not allowed precise identification. Female *Argonauta argo* empty shells were caught. However, they have not been considered due to the lack of animal and the fact that currents can drift the empty shells.

Table III shows the mean abundance and percentage of occurrence of the species of cephalopod collected in the present study. *Todarodes sagittatus* was the most abundant species followed by *Eledone cirrhosa* and *Rossia macrosoma*. These three species together constituted 72.75% of the total cephalopods abundance. *Octopus salutii, Todaropsis eblanae* and *Sepietta oweniana* were very frequent

Table IV. Depth ranges of the collected species off Alicante and in other areas.
Tabla IV. Rango de profundidades de las especies capturadas en Alicante y en otras zonas.

Species	Depth range (m)	Source	Location
Rhombosepion orbignyana	40-460	Sánchez, 1986	Mediterranean
Rossia macrosoma	125-450	Sánchez, 1986	"
Neorossia caroli	150-1744	Sánchez, 1986; Villanueva, 1992	"
Sepietta oweniana	22-974	Lumare, 1970; Villanueva, 1992	"
Loligo media	0-200	Sánchez, 1986	"
Abralia veranyi			
Onychoteuthidae			
Histioteuthis bonellii	220-430	Sánchez, 1986	"
Histioteuthis reversa	0-1766	Joubin, 1900; Villanueva, 1992	"
Illex coindetii	50-280	Sánchez, 1986	"
Todaropsis eblanae			
Todarodes sagittatus	20-1000	Mangold-Wirz, 1963	"
Octopus salutii	30-800	Sánchez, 1986	"
Octopus defilippi	6-60	Wirz, 1958	"
Scaeurgus unicirrhus	235-700	Sánchez, 1986	"
Pteroctopus tetracirrhus	110-570	Sánchez, 1986	"
Eledone cirrhosa	10-570	Sánchez, 1986	"
Bathypolypus sponsalis	120-1835	Mannini, 1989; Villanueva, 1992	"

in the hauls but they were not abundant in terms of biomass. Finally, 10 of the 18 species were caught in less than 20% of the hauls and none of them achieved abundances greater than 2 g/hectare.

The highest cephalopod catches occurred in summer and winter. *S. oweniana, T. eblanae* and *O. salutii* showed their highest abundances in winter, while *E. cirrhosa* showed a peak in summer and *T. sagittatus* a decreasing pattern from summer to spring. *R. macrosoma* achieved its highest abundance both in summer and winter (Fig. 2).

Table IV shows the depth ranges for the eighteen species collected in the present study, together with the known maximum and minimum depths recorded for the same species in the Mediterranean and in other areas.

DISCUSSION

Faunistical composition of the present study is similar to other studies carried out in the Western Mediterranean (SÁNCHEZ, 1986; SÁNCHEZ *ET AL.*, 1998; QUETGLAS *ET AL.*, 2000) and Gulf of Cádiz (GUERRA, 1982) for the same bathymetric stratum.

Depth ranges of the species caught in the sampling were similar to those shown in SÁNCHEZ (1986), GUERRA (1992) and QUETGLAS *ET AL.* (2000). Despite these similiarities, an individual of *Octopus defilippi* was caught in a trawl between 366 and 377 m depth. This species is rare in the Iberian peninsula coasts and its bathymetric distribution is between 6 and 60 m depth in the Mediterranean (GUerra, 1992). Nevertheless, it has been caught until 350 m depth in the Southern Coast of Portugal (REIS, CABIDO AND LEAL, 1984). Consistently, the bathymetric distribution range of this species in the Mediterranean should be extended. However, it was caught only once, so more data will be needed in order to confirm this fact. On the other hand, individuals of the squid *Loligo media* have been caught between 237 and 426 m depth, when the

Table IV. Continuation.
Tabla IV. Continuación

Depth range (m)	Source	Location	Depth range (m)	Source
			237-377	Present study
32-600	Mangold-Wirz, 1963	NE Atlantic	237-509	"
367-1332	Chun, 1913; Joubin, 1924	NW Atlantic	426-500	"
29-475	Bas *et al.*, 1976: Guerra, 1982	NE Atlantic	237-611	"
			237-426	"
			352-426	"
			366-377	"
70-2000	Mangold-Wirz, 1963	?	333-522	"
0-1332	Lu and Roper, 1979; Joubin, 1924	NW Atlantic	351-611	"
48-500	Mangold-Wirz, 1963	SW Atlantic	352-611	"
85- 660	Mangold-Wirz, 1963	SW Atlantic	237-509	"
0-1000	Clarke, 1966	NE Atlantic	351-611	"
			237-237	"
<350	Reis et al, 1984	NE Atlantic	366-377	"
70-430	Mangold-Wirz, 1963	Caribean Sea	237-244	"
70-680	Mangold-Wirz, 1963	Caribean Sea	352-509	"
10-770	Mangold-Wirz, 1963	NE Atlantic	366-500	"
358-930	Pérez-Gándaras and Guerra, 1978; Fischer and Joubin, 1906	NE Atlantic	400-444	"

known bathymetric distribution range of this species extends between the surface until 350 m depth (GUERRA, 1992).

Cephalopods represent a commercially important resource in Western Mediterranean but, deeper than 350 m, cephalopod catch rates are low and the majority of species have little or no commercial value (SARTOR *ET AL.*, 1998). In the Alicante upper slope fishery they contributed more to the discards (4.5%) than to the commercial catch (3.5%), being fishes and crustaceans the most important groups (SORIANO, 2000). The most abundant cephalopod species in this study were the squids *T. sagittatus* and *T. eblanae*, the octopuses *E. cirrhosa* and *O. salutii* and the sepiolids *R. macrosoma* and *S. oweniana*. The relatively high biomass of octopuses found in the trawl hauls may be explained by the benthic way of life of these animals, which increases the catchability of these species by the trawl gear. Moreover, the agreggational behaviour of squids (GUERRA, 1992) and sepiolids (VILLANUEVA, 1995) may explain the relatively high abundances of these groups in the catch.

Many authors studied changes in size distribution (i.e. VILLANUEVA, 1992; QUETGLAS, ALEMANY, CARBONELL, MERELLA AND SÁNCHEZ, 1998a), abundance (i.e. SÁNCHEZ, 1986; VILLANUEVA, 1995), biomass (i.e. SARTOR *ET AL.*, 1998; QUETGLAS *ET AL.*, 2000), reproductive parameters (i.e. QUETGLAS *ET AL.*, 1998a) and ecological parameters (i.e. QUETGLAS *ET AL.*, 2000) along the bathymetric gradient of cephalopods in the Western Mediterranean. To our knowledge, SÁNCHEZ (1986), QUETGLAS, ALEMANY, CARBONELL, MERELLA AND SÁNCHEZ (1998b), SÁNCHEZ *ET AL.* (1998) and SÁNCHEZ AND MARTÍN (1993) studied changes in cephalopods abundance according with season in this area. Nevertheless, they were not focused on deep-sea species. In this sense, information about biomass seasonal patterns of target and non-target species and the explanation of these patterns could be

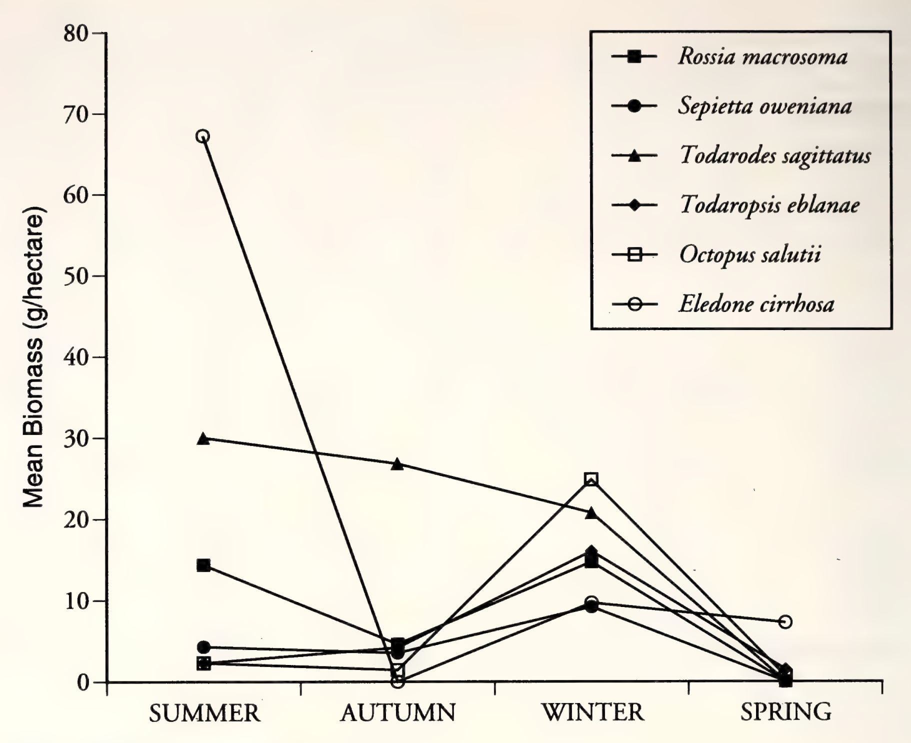


Figure 2. Seasonal abundances (in g/hectare).
Figura 2. Abundancias estacionales (en g/hectárea).

useful to understand the complex ecological relationships in the Western Mediterranean deep-sea and, in consequence, it may provide data for a better management of the fishery.

Seasonal changes of biomass observed in this study may be related with species life history (spawning and/or recruitment). *R. macrosoma* was caught in summer, autumn and winter, showing two peaks of abundance (summer and winter), being spring and autumn the spawning periods for this species in Western Mediterranean (GUERRA, 1992). In the present study no individuals of *R. macrosoma* were caught in spring, which agrees with observations by VILLANUEVA (1995). In the same way, *S. oweniana* spawns from March to November between 10 and 45 m depth (GUERRA, 1992), and its highest abundance level was observed in winter. It seems reasonable to think that both species may carry out reproductive migrations to depths out of present study sampling area.

The relatively high catch rates of *T. sagittatus* found in summer and autumn could be explained arguing that the spawning period of this species extends through these seasons, as observed in the Balearic Sea (QUETGLAS *ET AL.*, 1998a). On the other hand, the high catch rate could be also due to the fact that individuals are more concentrated during this period and, therefore, its catchability by the trawl gear increases. The decreasing trend in biomass from summer to spring could be related with changes in the intensity of spawning during the year, linked with a process of desaggregation after the spawning and due to a gradual ontogenic migration to deeper waters than local trawl fleet operation depths. In this sense, could be made a hypothesis about the existence

of a variable spawning depth according to season, in which, individuals would spawn in shallow waters in summer while it would perform an increasing in the spawning depth until winter, when spawning period finishes for this species.

ACKNOWLEDGEMENTS

Authors wish to thank the collaboration of the crew of the vessels "Almuixó" and "Arlandis Llorca", and Dr. R. Villanueva and E. Ojeda for helpful comments on the manuscript.

BIBLIOGRAPHY

BAS, C., ARIAS, A. AND GUERRA, A., 1976. Pescas efectuadas durante la campaña "Atlor V" (C. Bojador- C. Blanco, abril- mayo 1974). Características y tratamiento de las capturas. *Resultados de Expediciones Científicas del B/O Cornide Saavedra,* 5: 161-172.

BLANCO, C., AZNAR, J. AND RAGA, J. A., 1995. Cephalopods in the diet of the striped dolphin *Stenella coeruleoalba* from the western Mediterranean during an epizootic in 1990. *Journal of Zoology (London),* 237: 151-158.

CHUN, C., 1913. Cephalopoda. *Report on the Scientific Results of the "Michael Sars". North Atlantic Deep-Sea Expedition 1910,* 3 (1): 1-21.

CLARKE, M. R., 1966. A review of the systematics and ecology of oceanic squids. *Advances in Marine Biology,* 4: 91-300.

FISCHER, H. AND JOUBIN, L., 1906. Céphalopodes. Expéditions Scientifiques du "Travailleur" et du "Talisman". *Bulletin du Muséum National d'Histoire Naturelle, Paris,* 8: 313-353.

GUERRA, A., 1982. Cefalópodos capturados en la campaña «Golfo de Cádiz-81». *Resultados de Expediciones Científicas del B/O Cornide Saavedra,* 10: 17-49.

GUERRA, A., 1992. *Mollusca. Cephalopoda.* In: M. Ramos et al., Fauna Ibérica, Vol. 1. Museo Nacional de Ciencias Naturales. C.S.I.C., Madrid, 327 pp.

JOUBIN, L., 1900. Céphalopodes. *Résultats des Campagnes Scientifiques accomplies par le Prince Albert I, Monaco,*17: 1-135.

JOUBIN, L., 1924. Contribution à l'étude des Céphalopodes de l'Atlantique Nord. *Résultats des Campagnes Scientifiques accomplies par le Prince Albert I, Monaco,* 67 (4): 1-113.

LU, C. C. AND ROPER, C. F. E., 1979. Cephalopods from Deepwater Dumpsite 106 (Western Atlantic): vertical distribution and seasonal abundance. *Smithsonian Contributions to Zoology,* 288: 36 pp.

LUMARE, F., 1970. Nota sulla distribuzione di alcuni Cefalopodi del Mar Tirreno. *Bollettino di Pesca, Piseicoltura e Idrobiologia,* 25: 322-328.

MANGOLD-WIRZ, K., 1963. Biologie des Céphalopodes benthiques et nectoniques de la mer Catalane. *Vie et Milieu,* 13 (Suppl.): 1-285 pp.

MANNINI, P., 1989. Nota sulla presenza e distribuzione di alcuni cefalopodi del Tirreno Settentrionale. *Oebalia,* 15 (2): 693-701.

OLIVER, P., 1983. Los recursos pesqueros del Mediterráneo. Primera parte: Mediterráneo Occidental. *Etudes et Revues: Conseil Général des Péches pour la Méditerranée,* 59: 139 pp.

PÉREZ-GÁNDARAS, G. AND GUERRA, A., 1978. Estudio sobre algunas especies del género *Bathypolypus* (Cephalopoda: Octopoda) halladas en las costas de Galicia. *Investigación Pesquera,* 42 (1): 189-211.

QUETGLAS, A., ALEMANY, F., CARBONELL, A., MERELLA, P. AND SÁNCHEZ, P., 1998a. Some aspects of the biology of *Todarodes sagittatus* (Cephalopoda: Ommastrephidae) from the Balearic Sea (Western Mediterranean). *Scientia Marina,* 62 (1-2): 73-82.

QUETGLAS, A., ALEMANY, F., CARBONELL, A., MERELLA, P. AND SÁNCHEZ, P., 1998b. Biology and fishery of *Octopus vulgaris* Cuvier, 1797, caught by trawlers in Mallorca (Balearic Sea, Western Mediterranean). *Fisheries Research,* 36: 237-249.

QUETGLAS, A., CARBONELL, A. AND SÁNCHEZ, P., 2000. Demersal Continental Shelf and Upper Slope Cephalopod Assemblages from the Balearic Sea (North-Western Mediterranean). Biological Aspects of Some Deep-Sea Species. *Estuarine, Coastal and Shelf Science,* 50: 739-749.

REIS, C. A., CABIDO, M. T. J. AND LEAL, F. M. G. P., 1984. Distribuçao na costa portuguesa de 4 especies da familia Octopodidae (Mollusca: Cephalopoda). *Actas do IV Simpósio Ibérico de Estudos do Benthos Marinho. Lisboa,* 1: 203-217.

SÁNCHEZ, P., 1986. Distribución batimétrica y abundancia de algunos cefalópodos del mar Catalán. *Investigación Pesquera,* 50 (2): 237-245.

SÁNCHEZ, P., BELCARI, P. AND SARTOR, P., 1998. Composition and spatial distribution of cephalopods in two north-western Mediterranean areas. *South African Journal of Marine Science,* 20: 17-24.

SÁNCHEZ, P. AND MARTÍN, P., 1993. Population dynamics of the exploited cephalopod species of the Catalan Sea (NW Mediterranean). *Scientia Marina*, 57 (2-3): 153-159.

SÁNCHEZ, P. AND OBARTI, R., 1993. The biology and fishery of *Octopus vulgaris* caught with ceramic pots in Spanish Mediterranean coast. In: Okutani, T. (Ed.): *Recent Advances in Cephalopod Fisheries Biology*: 477-487.

SARTOR, P., BELCARI, P., CARBONELL, A., GONZÁLEZ, M., QUETGLAS, A. AND SÁNCHEZ, P., 1998. The importance of cephalopods to trawl fisheries in the western Mediterranean. *South African Journal of Marine Science*, 20: 67-72.

SORIANO, S., 2000. *Descarts de la pesca de ròssec al talús superior de la província d'Alacant*. Tesi de Llicenciatura. Univ. d'Alacant.

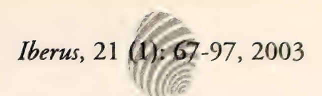
SWEENEY, M. J. AND ROPER, C. F. E., 1998. Classification, Type Localities, and Type Repositories of Recent Cephalopoda. *Smithsonian Contributions to Zoology*, 586 (2): 561-599.

VILLANUEVA, R., 1992. Deep-sea cephalopods of the north-western Mediterranean: indications of up-slope ontogenetic migration in two bathybenthic species. *Journal of Zoology*, 227: 267-276.

VILLANUEVA, R., 1995. Distribution and abundance of bathyal sepiolids (Mollusca: Cephalopoda) in the northwestern Mediterranean. *Bulletin de l'Institut Océanographique Monaco*, nº spécial 16: 19-26.

WIRZ, K., 1958. Céphalopodes. *Faune Marine des Pyrénées Orientales*, 1 (1): 5-59.

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On the phylogenetic significance of the aplacophoran Mollusca

Sobre la significación filogenética de los moluscos aplacoforos

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Recibido el 9-IX-2002. Aceptado el 13-XII-2002

ABSTRACT

The increase in our knowledge of the organisation of the aplacophoran Mollusca over the last decades is outlined and the arguments with respect to their systematic position and phylogenetic significance are discussed.

First, the analysis of the mantle cavity in Neomeniomorpha and Chaetodermomorpha reveals an independent evolutionary transformation of both: in neomeniomorphs by a lateral narrowing of the mucociliary-gliding body with internalisation of the (posterior) mantle grooves, in chaetodermomorphs by a terminal shift and inversion of the (posterior) mantle grooves and the reduction of the foot to burrow in sediment, with midventral fusion of the mantle rims from posterior to anterior (HOFFMAN, 1949). This confirms their diphyletic status derived from a common ancestral group; together with the absence of true synapomorphies, this allows the chaetodermomorphs to be separated as a proper clade Caudofoveata (Boettger, 1956) in contrast to the neomeniomorph aplacophorans or Solenogastres.

Second, the comparison of the alimentary tract and the excretory system in both classes with those in the monophyletic Testaria (Placophora + Conchifera) contradicts an origin of the aplacophoran Mollusca by regressive derivation from Placophora (as assumed by Pelseneer, 1890); rather, it confirms the conservative level of the aplacophoran organisation, which is also strongly supported by cladistic analysis.

Third, the mantle cover, the musculature, and the elaboration of the alimentary tract reflect a gradual anagenesis within Mollusca from the aplacophoran to the polyplacophoran and mono-placophoran (conchiferan) levels.

Fourth, within the Mollusca the Solenogastres have retained a primitive stage of the radula which, in its most conservative level, appears to be characterized by the monoserial type (median bars or two teeth with symphysis). In correlation with the cnidaria-vory in Solenogastres, a molluscan origin from ciliary-gliding, mesenchymate Spiralia is accepted, and the plesiomorphic conditions of molluscan characters are outlined.

RESUMEN

Se pone de manifiesto el mayor conocimiento sobre la organización de los moluscos aplacóforos en las últimas décadas y se discuten su posición sistemática y relevancia filogenética.

El análisis de la cavidad del manto en Neomeniomorpha y Chaetodermomorpha revela una transformación evolutiva independiente en ambos grupos: en el primero por un adelgazamiento lateral del cuerpo mucociliar con internalización de los pliegues posteriores

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del manto, en los Chaetodermomorpha por un cambio terminal e inversión de los pliegues posteriores del manto y la reducción del pie para enterrarse en el sedimento, con una fusión ventral de los bordes del manto de atrás adelante (HOFFMAN, 1949). Esto confirma su estatus difilético a partir de un ancestro común. Junto con la ausencia de verdaderas sinatopomorfías, esto permite separar a los Chaetodermomorpha como verdaderos Caudofoveata (Boettger, 1956) en contraste con los Solenogastres.

La comparación del tracto alimentario y el sistema excretor en ambas clases con las de los Testaria (Placophora y Conchifera) contradice un posible origen de los aplacóforos por derivación regresiva de los Plocophora (tal y como sugirio Pelseneer, 1890); esto confirma el nivel conservativo de la organización aplacófora, lo cual se sostiene también por análisis cladístico.

La cubierta del manto, la musculatura y la elaboración del tracto alimentario refleja una anagénesis gradual dentro de los moluscos, desde los aplacóforos a los poliplacóforos y los conchífera.

Dentro de los moluscos, los solenogastros han conservado un estadío primitivo de rádula que, en sus niveles más conservativos, es del tipo monoserial (piezas medias o dos dientes con sínfisis). En correlación con los solenogastros comedores de cnidarios, se acepta un origen a partir de Spiralia mesenquimáticos con desplazamiento ciliar, y se indican las condiciones plesiomórficas de los caracteres de moluscos.

KEY WORDS: *Aplacophora*, Solenogastres, Caudofoveata, molluscan phylogeny.
PALABRAS CLAVE: *Aplacophora*, Solenogastres, Caudofoveata, filogenia de moluscos.

INTRODUCTION

The purely marine aplacophoran molluscs are classified in two taxa, the chaetodermomorphs or Caudofoveata and the neomeniomorphs or Solenogastres (Fig. 1), known since 1845 (*Chaetoderma*: Lovén) and 1875 (*Neomenia*: Tullberg), respectively. A first period of enlargement in knowledge began in 1877 and stretched to 1921, with the description of many new species of both chaetodermatids and neomeniids (mainly Koren and Danielssen, Hubrecht, Kowalevsky and Marion, Pruvot, Wirén, Thiele, Nierstrasz, Heath, Odhner; see SIMROTH, 1893b, HOFFMANN, 1929). A second period may be outlined from1938-1950, with investigations by Baba, Stork, Leloup, Hoffman and Schwabl (see FISCHER-PIETTE AND FRANC, 1960, HYMAN, 1967); a third period began in 1967 involving L. v. Salvini-Plawen and since 1972 likewise A. Scheltema. Overviews and compilations of organisation are given by SALVINI-PLAWEN (1971, 1972a, 1985) and SCHELTEMA, TSCHERKASSKY AND KUZIRIAN (1994). Most of these investigations concern organisational diversity based on descriptions of species, but comprehensive collections still await elaboration. Due to the habitat of members of both the chaetodermomorphs/Caudofoveata and the neomeniomorphs/Solenogastres (mostly below 40 meters depth) living observations, biological data and physiological investigations are still rare. However, the work over the last decades has contributed considerably to elucidating the systematic position of the aplacophorans and to underlining their phylogenetic significance.

Scientific results in the phylogenetic context suffer from two properties: they are often evaluated one-sidedly in relation to a predominant or central group (for molluscs: gastropods or conchiferans in general), and there is an inflexible trend to press them into some beloved theory (e.g. molluscs as altered coelomates or even articulates) rather than to adapt or reject hypotheses based on new

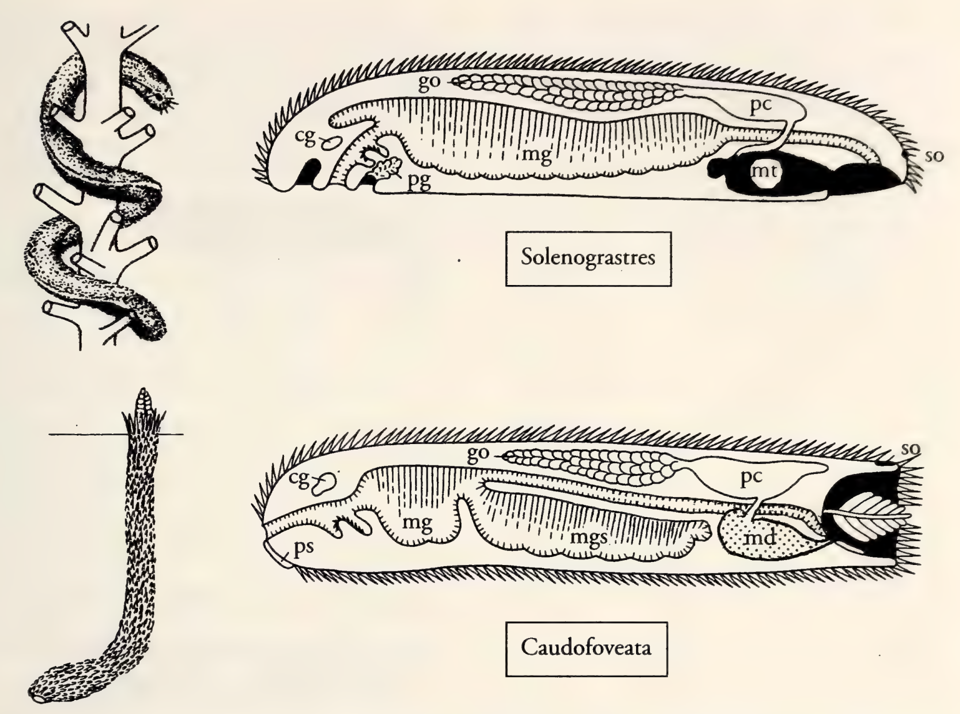


Figure 1. Aplacophoran Mollusca. External aspect of an animal (Solenogastres: *Nematomenia banyulensis*; Caudofoveata: *Falcidens sagittiferus*), and organisational sketch of alimentary tract, gono-pericardial system and mantle cavity. cg: cerebral ganglion; go: gonad; md: glandular duct; mg: midgut; mgs: unpaired midgut sack; mt: spawning duct (internalised mucous tract of mantle groove); pc: pericardium; pg: pedal gland; ps: pedal shield; so: dorsoterminal or osphradial sense organ.

Figura 1. Moluscos Aplacóforos. Aspecto exterior de un animal (Solenogastres: Nematomenia banyulensis; *Caudofoveata:* Falcidens sagittiferus*), y esquema de la organización del tracto digestivo, del sistema gono-pericárdico y de la cavidad paleal. cg: ganglio cerebral; go: gónada; md: conducto glandular; mg: intestino medio; mgs: saco impar del intestino medio; mt: conducto del desove (tracto mucoso internalizado del surco paleal); pc: pericardio; pg: glándula pedal; ps: escudo pedal; so: órgano sensorial dorsoterminal u osfradial.*

facts and results. The aplacophoran molluscs, as two small, conservative taxa, additionally suffer from the great effort and expense to collect them. Our standard of knowledge is therefore weak compared with other molluscan groups. They are thus often not seriously considered in comparative evaluations, be it due to their low number, be it that the "a-placophoran" condition suggests a regressive state, or be it that they are regarded as aberrant inconveniences that are not equivalent to "true" molluscs.

1. THE DIPHYLY/PARAPHYLY OF *APLACOPHORA *

The two aplacophoran taxa exhibit a dorsal integument (mantle) with calcareous (aragonitic) products, a mantle cavity with body outlets, a radula, a tetraneurous nervous system, and a gono-pericardium including a heart that performs open circulation and ultrafiltration. In spite of their unfamiliar appearance they are thus true Mollusca. Additional characters in each of the two groups unequivocally confirm them as members of the phylum.

When IHERING (1876) created (within Amphineura) the Aplacophora in contrast to Placophora, he emphasized the different organisation of Chaetodermatidae and Neomeniidae from chitons. GEGENBAUR (1878: 139) proposed for the group which has "a more distinct separation of the ventral side through the differentiation of a furrow", the name Solenogastres; unfortunately and misleadingly he also included *Chaetoderma* based on the erroneous description by GRAFF (1877) of the dorsoterminal sense organ as the vestige of a ventral furrow. As early as 1883, Lankester classified Neomeniae and Chaetoderma as equivalent orders to Polyplacophora within his Isopleura. In Lankester´s Treatise, PELSENEER (1906) again grouped his orders Neomeniomorpha and Chaetodermomorpha below Aplacophora, a classification that has been retained by many authors up to present. Decisive insights, however, were presented by HOFFMAN (1949). His detailed histological, comparative investigation on the mantle cavities of *Chaetoderma nitidulum* Loven, 1845, *Proneomenia "antarctica"* (= *Dorymenia hoffmani* S.-Plawen, 1978) and *Leptochiton asellus* (Gmelin, 1791) revealed the diphyletic status of recent aplacophorans (Fig. 2). The posterior mantle grooves in lower representatives of the (secondarily much flattened) Placophora are provided with mucous tracts as well as with the outlets of gonoducts and excretory organs (Fig. 2A); these tracts parallel in extension at least the merobranchiate elaboration of ctenidia. This paired section of the mantle cavity in the ctenidia-less neomeniomorphs/Solenogastres is represented by the glandular spawning ducts (also known as shell glands or "lower gonoducts"). Consequently, as in other molluscs, the mesodermal pericardioducts open directly into the ectodermal mantle cavity, i.e. here into the internalised mucous tracts or spawning ducts (Fig. 2B). This condition is clearly evidenced also in juvenile specimens, in which the anlagen of the pericardioducts come from the mesodermal pericardium and the anlagen of the spawning ducts emerge from the ectodermal mantle cavity rudiment (cf. e.g. BABA,1938 for *Epimenia babai* S.-Plawen, 1997, SALVINI-PLAWEN, 1978 for *Neomenia laminata* S.-Plawen, 1978, or TODT AND SALVINI-PLAWEN, 2003 for *Spiomenia prematura*).

In contrast, in chaetodermomorphs/Caudofoveata the mucous tracts of the posterior mantle grooves as well as the ctenidia (one pair) are retained as free structures; here, however, they are arranged upside down ventrally in the mantle cavity (HOFFMAN, 1949). In addition, the pericardioducts are not directly connected to the (mucous tracts of the) mantle cavity; rather, they each lead out into a pair of voluminous glandular organs of unknown homology (see below); only these glandular ducts or sacks open lateroventrally into the mucous tracts (Fig. 2C). Both the arrangement of the mucous tracts (present in all females, rarely in males) and the position of those openings demonstrate an inversion of the organs (HOFFMAN, 1949). Thus, the mantle cavity configurations of neomeniomorphs and chaetodermomorphs are clearly different from each other. In neomeniomorphs they reflect an evolutive slendering of their forerunners: the ciliary-gliding body narrows, with the foot becoming a mere pedal groove, and the (posterior) mantle grooves internalise to become the present spawning ducts. In contrast, the precursors of the chaetodermomorphs — as sediment burrowers — underwent a terminal shift of the (posterior) mantle grooves and a ventral fusion of the mantle rims into a tube (cf. Scaphopoda); this included an inversion of the mucous tracts and ctenidia. This development was paralleled by the reduction of the foot with midventral fusion of the mantle rims from posterior to anterior (see the midventral anterior mantle suture in some *Scutopus* species). The result was a cylindrical, worm-like habit.

These scenarios clearly reflect two totally different evolutionary processes: neither can the chaetodermophorph

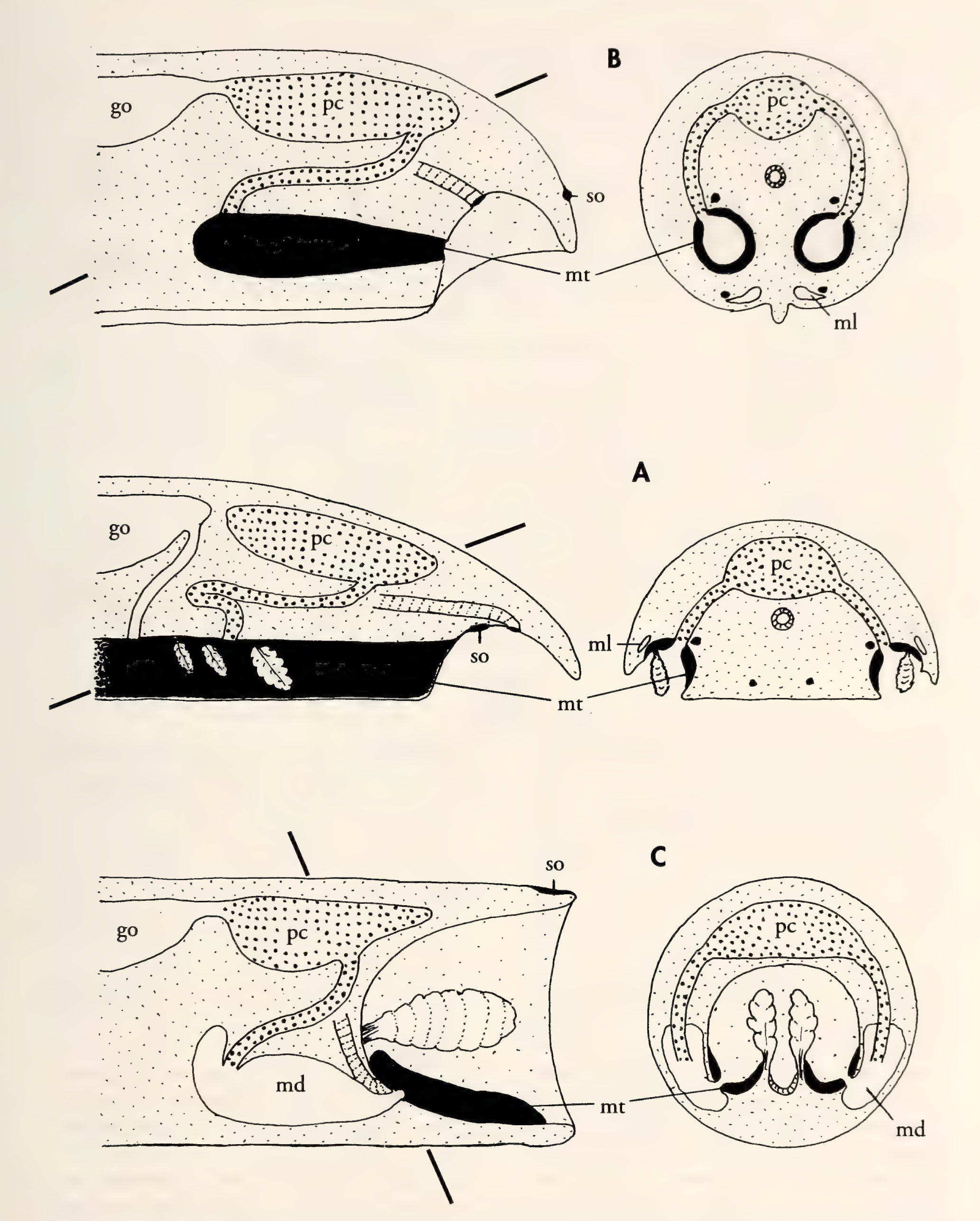


Figure 2. Relation of pericardium, pericardioducts and mantle cavity in A Placophora (with ctenidia), B Solenogastres and C female Caudofoveata (with ctenidia). At left schematic views from lateral, at right schematic views projected from behind according to oblique cross sections indicated at left. go: gonad; md: glandular duct; ml: musculus longitudinalis; mt: mucous tract of mantle groove; pc: pericardium; so: osphradial sense organ.

Figura 2. Relación del pericardio, de los pericardioductos y de la cavidad paleal en A Placophora (con ctenidios), B Solenogastres y C Caudofoveata femeninos (con ctenidios). A la izquierda vistas esquematicas de lateral, a la derecha vistas esquematicas por atrás según las secciones transversales indicadas. go: gónada; md: conducto glandular; ml: musculus longitudinalis; mt: tracto mucoso del surco paleal; pc: pericardio; so: órgano sensorio osfradial.

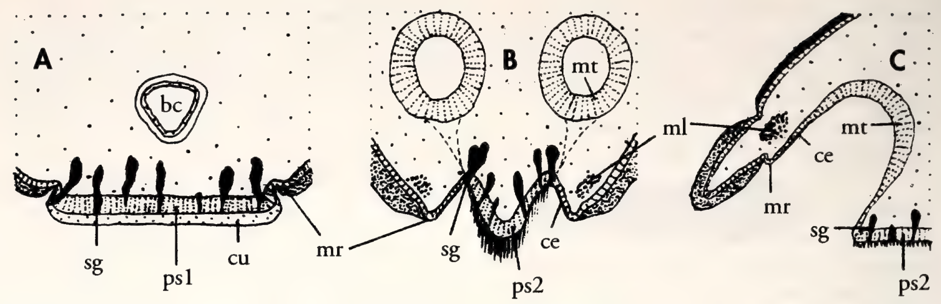


Figure 3. Structures of ventral body adjacent to mantle rim in A Caudofoveata (region of pedal shield), B Solenogastres (region of spawning ducts / mucous tracts), C Placophora (region of mucous tracts) (after SALVINI-PLAWEN, 1991). ce: microvillious epithelium of mantle groove; cu: irregularly-arranged microvilli within matrix of glycocalix; ml: musculus longitudinalis; mr: mantle rim (inner mantle fold); mt: mucous tract of mantle groove; ps1: pedal shield (cerebrally innervated); ps2: pedal sole (ventrally innervated); sg: glands of pedal shield or sole.

Figura 3. Estructuras del cuerpo ventral contiguo al margen del manto A en Caudofoveata (región del escudo pedal), B en Solenogastres (región de los tractos mucosos / conductos de desove), C en Placophora (región de los tractos mucosos) (según SALVINI-PLAWEN, 1991). ce: epitelio microvilloso del surco paleal; cu: estrato de glycocalix con microvilli irregulares ; ml: musculus longitudinalis; mr: margen del manto (pliegue interor del manto); mt: tracto mucoso del surco paleal; ps1: escudo pedal (de inervación cerebral); ps2: suela pedal (de inervación ventral); sg: glándulas del escudo pedal o de la suela pedal.

configuration be derived from the neomeniomorph conditions, nor vice versa (see Fig. 2). Both arrangements are comprehensible only when each derived from ancestors whose posterior body bore a peripedal mantle groove with mucous tracts and the outlets of the pericardioducts. Such a relation of the two aplacophoran groups clearly reflects a diphyly (or, including the more flattened Placophora, a triphyly). Thus, BOETTGER (1956) separated the chaetodermomorphs as Caudofoveata from other, neomeniomorph aplacophorans with a pedal groove: Ventroplicida (Boettger, 1956) = Solenogastres (Gegenbaur, 1878, emend. SIMROTH, 1893a). SALVINI-PLAWEN (1967) finally accepted both as independent classes equivalent to Placophora. Are there synapomorphies of one of these classes with the Placophora (or other molluscan group)? Up to the present no conclusion can be drawn about whether — within paraphyletic aplacophorans – the Caudofoveata or the Solenogastres are, from the cladistic point of view, the sister-group of Placophora. Referring to the Solenogastres, we may assume that their precursors were likewise provided with anterio-lateral mantle grooves that underwent regression during evolutive transformation (HOFFMAN, 1949). This is supported by the presence of a pedal gland, which suggests a former separation of the cerebrally innervated perioral region (snout, "head"-portion) from the ventrally innervated foot with pedal gland. This would equalise the atrial sense organ or vestibulum of Solenogastres with the pre-oral mantle groove (HOFFMAN, 1949). On the other hand, it is not clear whether such precursors were already provided with ctenidia (see below). In contrast, at present we cannot advance similar assumptions about the regression of mantle grooves in Caudofoveata. They show no vestige of a pedal gland, and consequently we do not know whether the mantle grooves of their flattened ancestors also extended into the anterior body. The post- to peri-oral, secondarily cuticularised buccal plate or pedal shield reflects a histology and configuration similar to that of the pedal groove in

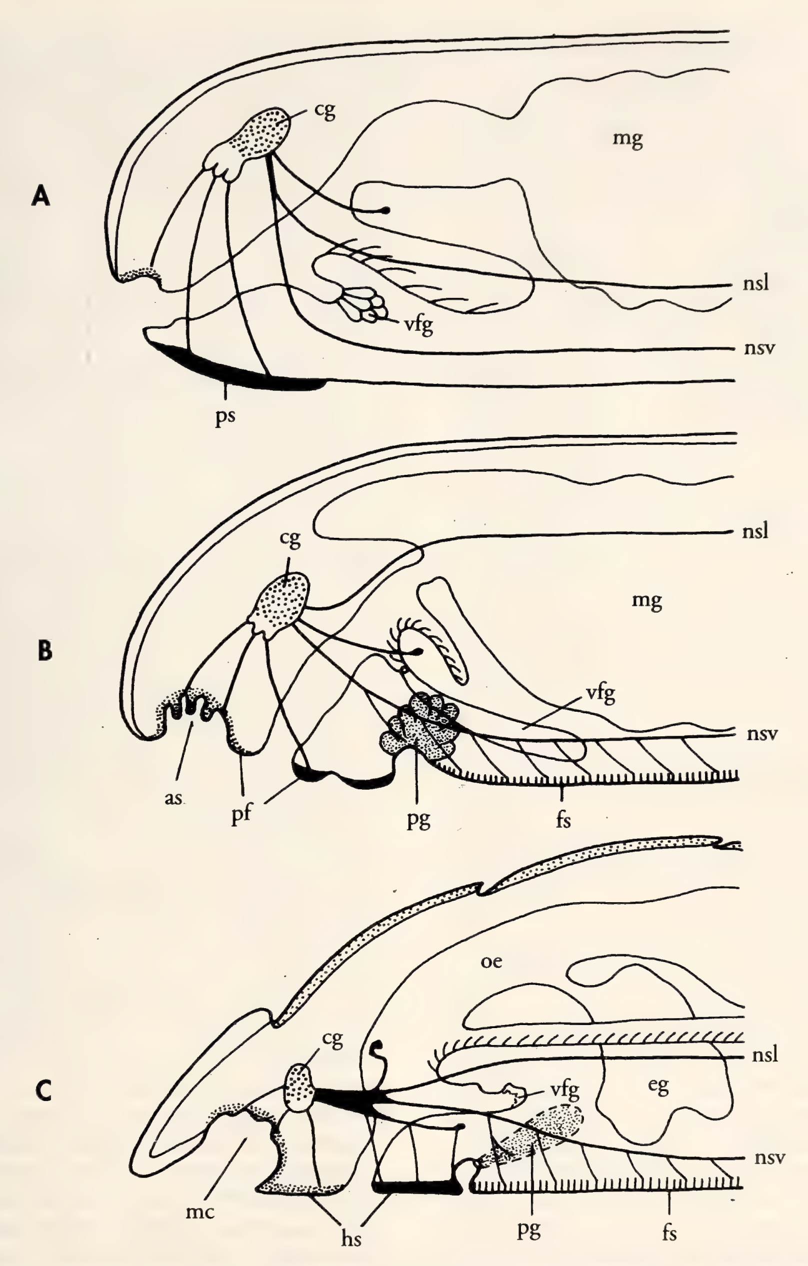


Figure 4. Innervation areas in the ventral anterior body (with identical marking) of A Caudofoveata, B Solenogastres, C Placophora. as: atrial sense organ; cg: cerebral ganglion; eg: esophageal gland; fs: foot (pedal sole); hs: head plate; mc: anterior mantle groove; mg: midgut; nsl: lateral nerve cord; nsv: ventral nerve cord; oe: esophagus; pf: peri-oral fold (snout); pg: pedal gland; ps: pedal shield; vfg: ventral foregut gland.

Figura 4. Áreas de inervación del cuerpo anterior ventral (marcadas identicamente) en A Caudofoveata, B Solenogastres, C Placophora. as: órgano sensitivo atrial; cg: ganglio cerebral; eg: glándula esofágica; fs: pie (suela pedal); hs: cabeza; mc: surco paleal anterior; mg: intestino medio; nsl: cordón nervioso lateral ; nsv: cordón nervioso ventral; oe: esófago; pf: hocico; pg: glándula pedal; ps: escudo pedal; vfg: glándula ventral de la faringe.

Solenogastres and the foot in Placophora (HOFFMAN, 1949, SALVINI-PLAWEN, 1972a; Fig. 3); the fine structural organisation (SALVINI-PLAWEN, 1991, SCHELTEMA *ET AL.*, 1994) neither supports nor contradicts the suggestion that the shield might be derived from an anterior portion of the ancestral foot. Yet, the pedal shield is cerebrally innervated (SALVINI-PLAWEN, 1972a; Fig. 4), and it could therefore be interpreted to represent the remnant of a formerly more extended (ventrally *and* cerebrally innervated) ventral locomotory organ (SALVINI-PLAWEN, 1972a, 1981a); the mantle grooves in such case were restricted to the posterio-lateral body.

Despite these as yet unsettled conditions regarding the configuration of the common ancestral anterior body (no organogenesis known in Caudofoveata), the different organisation of the posterior body in the two groups (mantle cavity; Fig. 2) unequivocally demonstrates the diphyly of Solenogastres and Caudofoveata. That diphyly is also strongly evidenced by cladistic analysis, which either proposes a paraphyly of aplacophorans with (dependent on character choice and coding) the Solenogastres or the Caudofoveata as first offshoot (SALVINI-PLAWEN AND STEINER, 1996, HASZPRUNAR, 2000), or results in a compromise-polytomy (triphyly) of Solenogastres, Caudofoveata and Placophora (which in strict Hennigian cladistics always includes a not yet solved paraphyly). To date there are no comparative data from molecular sequences to give support to one or the other side: The available 18S rDNA sequence of *Scutopus* (Caudofoveata) clusters inmidst of the Mollusca (WINNEPENNINCKS, BACKELJAU AND DE WACHTER, 1996); attempts at sequencing the 18S rDNA gene of threee different species of Solenogastres merely identified gut contents as diverse Cnidaria (Dr. Hermann Dreyer, Wien, unpublished), a result also obtained by other investigators (pers. comm.; see also WINNEPENNINCKS *ET AL.*, 1996); probably only DNA sequences of non-feeding larvae might provide valuable information. Polytomy is thus presently preferred, being supported by the manifold differences in the organisation between the three groups (e.g. SALVINI-PLAWEN, 1972a, 1985; see Table I). Diphyly of recent aplacophoran molluscs is even strikingly evident in "monophyletic" representations (SCHELTEMA, 1978, SCHELTEMA *ET AL.*, 1994), with their separate treatment of organ systems of each group. Finally, besides the sexual condition (hermaphroditism in Solenogastres), the single preoral ciliary trochus in larvae of Solenogastres also contrasts to the three preoral trochi in *Scutopus* and *Chaetoderma* (Caudofoveata; SALVINI-PLAWEN, 1991, NIELSEN, 1995) as well as in other groups (OKUSU, 2002).

Paraphyly of *Aplacophorans* with diphyly of recent groups is in accordance with the (prerequisite) lack of true synapomorphies (in contrast to SCHELTEMA, 1996, IVANOV, 1996). The mantle cover of cuticle and unicellularly formed aragonitic sclerites, likewise elaborated at the girdle/perinotum of Placophora (HOFFMAN, 1949, HAAS, 1981), represents a plesiomorphic character, as does the lack of excretory organs (emunctoria) for the secondary urine in aplacophoran organisation (see below). The so-called ganglionated nervous system is only present in the Solenogastres: They mostly possess medullary ventral and lateral body cords combined with more or less distinctly outlined, fairly serial ganglia; all stages between a predominantly medullary condition and a true separation of carya into ganglia interconnected by pure fibrous portions have been observed. In Caudofoveata, however, the medullary system shows only a few ganglia (buccal ganglia, large ventral ganglion at the beginning ventral cords, precerebral ganglia; SALVINI-PLAWEN, 1972a); this reflects a similar condition in Placophora (buccal and subradular ganglia). Thus, in contrast to Solenogastres, no ganglionisation of body cords can be stated in Caudofoveata. The originally paired osphradial sense organ is also clearly a molluscan plesiomorphy (SALVINI-PLAWEN, 1981a, HASZPRUNAR, 1987). The position of the latter in Caudofoveata is at the dorsal border of

Table I. Comparison of characters in Solenogastres, Caudofoveata and Placophora.
Tabla I. Comparación entre los caracteres de Solenogastres, Caudofoveata y Placophora.

Character	Solenogastres	Caudofoveata	Placophora
Chitinous cuticle	present	present	present
Mantle sclerites	scales, spicules	scales	scales at girdle
Foot	groove with folds	reduced	large foot
Pedal gland	present	no gland	present in larvae
Cerebral portion	mouth/snout+ atrium	mouth + buccal/pedal shield	head disc+anterior groove
Osphradial sense organ	at dorsoterminal mantle area	at dorsoterminal mantle border	within mantle cavity
Ctenidia	no ctenidia	one pair	5-88 pairs
Mucous tracts of mantle cavity	internalised	free, upside down	free, at roof
"Lower gonoducts" of literature	part of mantle cavity (spawning ducts/ mucous tracts)	"glandular ducts" between pericario-ducts and mantle cavity	distal portion of proper gonoducts
Excretory organ (emunctoria)	no emunctoria	function assumed by "glandular ducts"?	central portion of pericardioducts
Outlet of gonads	gono-pericardioducts	gono-pericardioducts	gonoducts
Body wall musculature	present, only below mantle	present, ventrally fused below mantle	vestigial, only below mantle
M. longitudinalis	present	vestigially present	present (?)
Bundles of dorso-ventral musculature	serially arranged	serial, but vestigial	16 pairs
Nervous sytem	ganglionated	medullary	medullary
Latero-terminal commissure	supra-rectal	supra-rectal	supra-rectal
Subradular organ	not present	not present	present
Radula membrane	no separate pre-ribbon	separate pre-ribbon	separate ribbon
Radula	monoserial-distichous, polystichous-polyserial	distichous	polystichous in paired anlage
Radula support	very simple to complex with turgescent cells	two compact bolsters	two vesicles with cartilages
Ventral foregut glandular organs	paired follicles to elaborate organs	paired follicles	vestigial pouches of subradular sack
Anterior midgut	body-filling	body filling	narrow esophagus + stomach + glands
Posterior midgut	body-filling	midgut duct+ midgut sack	narrowed to looped intestine
Heart (ventricle)	invagination of pericardium	in part invagination of pericardium	invagination of pericardium
Aorta	no aorta	present	present
Sex	hermaphroditism	separate sexes	mostly separate sexes
Sperm	derived introsperms	modified aquasperms	modified aquasperms
Larval type	pericalymma, stenocalymma	stenocalymma	pseudo-trochophora
Preoral trochi of larvae	one	three	one or two
Locomotion	muco-ciliary gliding	burrowing	muco-ciliary gliding
Nutrition	carnivory	micro-omnivory	predominantly herbivory

the mantle cavity and in Solenogastres dorsally outside the mantle cavity (in *Neomenia labrosa* S.-Plawen, 1978, the position is likewise outside the retracted mantle cavity: misinterpretation by IVANOV, 1996). This dorsoterminal location is different in detail and is thus too ambivalent to serve as a good synapomorphy. This also holds true for the gonopericardioducts (paired interconnection between gonads and pericardium) in both aplacophoran groups.

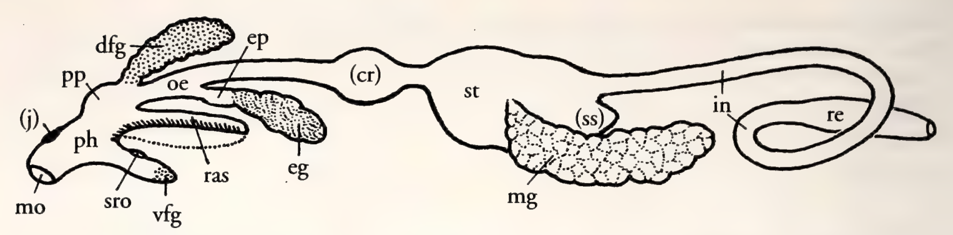


Figure 5. Regionated alimentary tract of Testaria (Placophora + Conchifera) (after MIZZARO-WIMMER AND SALVINI-PLAWEN, 2001). (cr): crop (Conchifera only); dfg: salivary gland(s); eg: esophageal gland; ep: esophageal pouch; in: intestine; (j): jaw (Conchifera only); mg: midgut gland; mo: mouth opening; oe: esophagus; ph: pharynx; pp: pharyngeal pouch; ras: radula sheath; re: rectum; sro: subradular organ; (ss): style sack (Conchifera only); st: stomach; vfg: ventral foregut gland(s).

Figura 5. Tracto digestivo subdividido de los Testaria, (según MIZZARO-WIMMER Y SALVINI-PLAWEN, 2001). (cr): papo (solo Conchifera); dfg: glándula(s) salivar(es); eg: glándula esofágica; ep: bolsa esofágica; in: intestino delgado; (j): mandíbula (solo Conchifera); mg: glándula del intestino medio; mo: boca; oe: esófago; ph: faringe; pp: bolsa faríngea; ras: bolsa de odontoblastos; re: recto; sro: órgano subradular; (ss): saco del estilo (sólo Conchifera); st: estomago; vfg: glándula(s) ventral(es) de la faringe.

This condition either is a retained plesiomorphy of pre-testarian configuration, or it represents a paedomorphy (as convergent apomorphy or synapomorphy?). Based on the different evolutive transformation of the posterior body (see above), it may also reflect true autapomorphies in both Caudofoveata and Solenogastres (see below, chapt. 6).

2. MIDGUT AND EMUNCTORIA

A comprehensive analysis of the digestive systems in Mollusca (SALVINI-PLAWEN, 1981b, 1988a) demonstrates two principal configurations of the postradular alimentary tract: either a simple, basically body-filling midgut (*Aplacophora*; Fig 1), or a midgut axially regionated into oesophagus with paired glandular pouch, stomach with paired digestive gland, and a narrowed, wound to enrolled intestine (Testaria; Fig. 5). The detailed coincidence of the organ system between Placophora and conservative Conchifera also includes the subradular organ, the radular bolster, the anterior oesophagus with dorsal food channel and the simple posterior esophagus (SALVINI-PLAWEN 1988a). All these clearly synapomorphic elaborations in Placophora and Conchifera define the monophyletic Testaria (SALVINI-PLAWEN, 1972a, 1985, 1991; WINGSTRAND, 1985).

In contrast, the Solenogastres possess a through-going, uniformly body-filling midgut (middorsally confined by the gonads) without regionation.The Caudofoveata show a basically similar midgut, yet with a posterior splitting into midgut sack and midgut duct ("intestine"). This latter exit canal is an asymmetrically dorsal-right, longitudinal subdivision of the posterior midgut, leaving the main portion as a single, voluminous blind sack (Fig. 1). As demonstrated elsewhere (SALVINI-PLAWEN, 1981b, 1988a), this longitudinal splitting is evidenced by the most conservatively represented configuration in some members of the Limifossoridae [e.g. *Psilodens elongatus* (S.-Plawen, 1972)]: in these the undivided (anterior) midgut and the midgut sack still exhibit an identical histological elaboration, thus still forming a histological entity. Terminally, the midgut duct continues in the ventrally inclined hindgut to open at the bottom of the mantle cavity. Thus, in contrast to the Testaria (Fig. 5), in which the midgut glands principally are a paired lateral pouching of the stomach

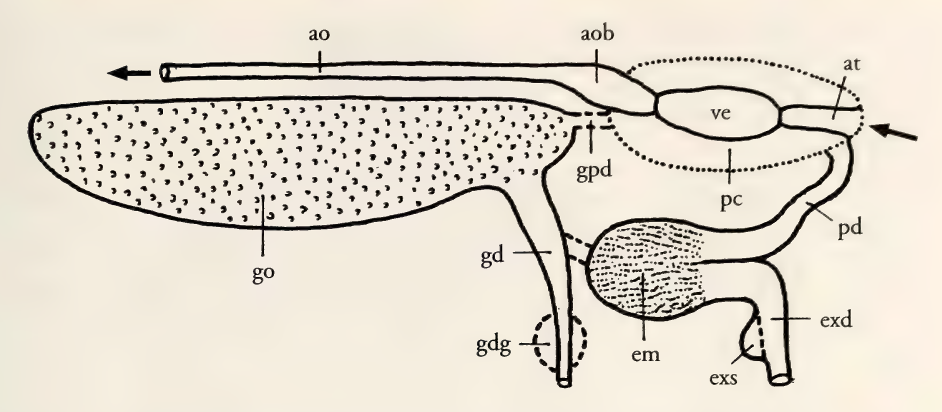


Figure 6. Gono-pericardial system of Testaria (Placophora + Conchifera) (after MIZZARO-WIMMER AND SALVINI-PLAWEN, 2001). ao: aorta; aob: bulb of aorta; at: heart auricle; em: emunctorium (excretory organ); exd: lower pericardioduct or excretory duct ("ureter"); exs: excretory sack; gd: gonoduct; gdg: gonoduct gland; go: gonad; gpd: gono-pericardial interconnection; pc: pericardium; pd: upper pericardioduct ("reno"-pericardial canal); ve: ventricle.

Figura 6. Sistema gono-pericárdico de los Testaria (según MIZZARO-WIMMER Y SALVINI-PLAWEN, 2001). ao: aorta; aob: bulbo del aorta; at: aurícula; em: emunctorio (órgano excretor); exd: conducto excretor; exs: saco excretorio; gd: gonoducto; gdg: glándula del gonoducto; go: gónada; gpd: comunicación gono-pericárdica; pc: pericardio; pd: pericardioducto proximal (canal reno-pericárdico); ve: ventrículo.

(central midgut region) and the intestine is a subsequent narrowed posterior midgut, in Caudofoveata both the midgut sack and the midgut duct ("intestine") together represent the posterior midgut. These midgut relations in Caudofoveata and Testaria therefore cannot be evaluated as being homologous, and a unifying taxon *Hepagastralia* (HASZPRUNAR 2000) consequently is misleading.

Though change in nourishment — such as from herbivory to carnivory — is followed by reorganising adaptations in the alimentary tract, such reorganisation towards carnivory merely involves a simplification of the existing configuration (with stomach, etc.). As demonstrated in several conchiferan groups (e.g. Cephalopoda, Scaphopoda, "Septibranchia"; cf. SALVINI-PLAWEN 1988a), however, the configuration itself remains unaltered and the genetic information for the regionated midgut of Testaria is not suppressed. Despite a regulative plasticity of the alimentary tract — in comparative view with cephalopods etc. — a reorganisation of the midgut relations in Testaria-Placophora towards those in Solenogastres and/or Caudofoveata (PELSENEER, 1890) appears to be an out-dated speculation (see also NIERSTRASZ, 1910, and HOFFMANN, 1930). The main point is that the uniformly body-filling midgut of Solenogastres (and, longitudinally subdivided, of Caudofoveata) refers to a primary configuration rather than a regressive adaptation from a regionated testarian midgut.

The excretory system in Testaria typically performs two different functions. In Placophora and Conchifera a primary urine is produced by ultrafiltration through podocytes at the atrial heart epithelum (ØKLAND, 1980, 1982, ANDREWS, 1981, 1988, REYNOLDS, 1990). This primary urine is drained out of the pericardium by the pericardioducts ("renopericardial" canals). Here, the central portion of the two pericardioducts is elaborated to secrete solutes, to reabsorb organic molecules as well as to abstract resulting waste material. By an emunctorial process it produces the secondary urine and thus represents an

excretory organ ("kidney") or emunctorium, with the outleading lower pericardioduct — excretory duct or exit canal ("ureter") — opening into the mantle groove or cavity (Fig. 6). In Solenogastres, the production of the primary urine is likewise performed by the atrial heart epithelium (REYNOLDS, MORSE AND NORENBURG, 1993, MORSE AND REYNOLDS, 1996). In contrast to Testaria, however, the pericardioducts are simple, variably ciliated mesodermal outlets which open into the internalised mucous tract portions of the ectodermal mantle cavity (spawning ducts, see Figure 2); the pericardioducts exhibit no transformation into an excretory organ (emunctorium), and no secondary urine is produced.

In Caudofoveata the primary urine produced by the atrial heart epithelium (SALVINI-PLAWEN AND BARTOLOMAEUS, 1995) is drained by the ciliated pericardioducts into the voluminous glandular ducts, which, in turn, then open into the mantle cavity (Fig. 2). As the organogenesis and morphological significance of these glandular ducts or sacks are unknown (see below), no homology can be ascertained. Crystals or electron-dense vacuolated inclusions appear to be present in the cells of the glandular ducts (WIREN, 1892: 55; HEATH, 1911: 54 and 71; SCHELTEMA, 1978; Tscherkassky in SCHELTEMA *ET AL.*, 1994: Fig 23G), indicating potential formation of excretory products. Yet, these latter organs themselves ("coelomoducts" in SCHELTEMA, 1978, "lower gametoducts" in MORSE AND REYNOLDS, 1996) are not part of the pericardioducts (see below) and thus appear not to be homologous to emunctoria. At best, they could represent analogous organs autapomorphically adapted to an equivalent or similar excretory function in caudofoveate forerunners.

The organisation of both organ systems clearly demonstrates that the axial regionation of the midgut as well as the elaboration of pericardioducal excretory organs in Testaria are evolutionary novelties (autapomorphies) that are not yet differentiated at the aplacophoran level; a postulated loss of excretory organs (SCHELTEMA, 1996 in contrast to IVANOV, 1996) is not supported by organogenesis (see above). On the other hand, the pallial position of the excretory organs outside the dorsoventral musculature in Tryblidia and Bivalvia (in contrast to Placophora; HASZPRUNAR AND SCHAEFER, 1997b) could be interpreted such that the elaboration of emunctoria is polyphyletic. Based on these and other arguments (SALVINI-PLAWEN, 1988b, SALVINI-PLAWEN AND BARTOLOMAEUS, 1995), the excretory organs in Mollusca-Testaria, though functionally reflecting a so-called metanephridial system (RUPPERT AND SMITH, 1988), have organogenetically (morphologically) nothing to do with "metanephridia" (or "nephridia", "kidneys") of other animal groups. In order to avoid unjustified homologisations and for the sake of accuracy, the testarian organs should preferably be termed emunctoria (see HOFFMANN, 1934, 1937).

3. RADULA CONFIGURATIONS

The Solenogastres, with their retained conservative midgut, exhibit a remarkable diversity in the mantle characters, in the types of radula, and in the elaboration of the accessory genital organs. The conservative level of Solenogastres, classified according to their mantle cover as Pholidoskepia, is clearly reflected by a thin cuticle with solid, scaly sclerites. This conservative level is also evidenced by the same condition in Caudofoveata and Placophora (see below). The basal mantle configuration in Solenogastres, i.e. scales, is supported by the change of the primary scales to hollow spicules during metamorphosis in *Rhopalomenia aglaopheniae* (Kow. and Mar., 1887) and *Epimenia babai* (Pruvot, 1892, OKUSU, 2002), both belonging to the advanced level of Cavibelonia. Also, Pholidoskepia either possess poorly outlined ventral foregut glandular organs (comparable to those in Caudofoveata) or a paired duct with

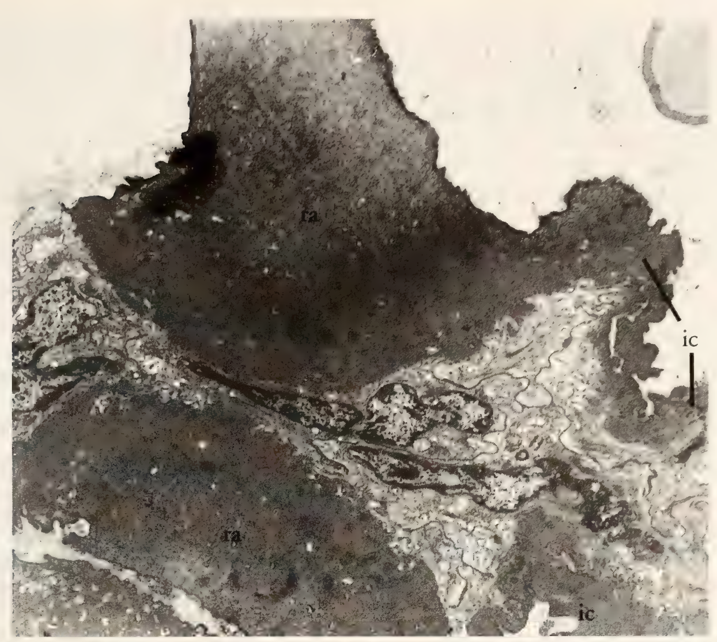


Figure 7. EM cross section through left part of most anterior radula of *Wirenia argentea*, with dorsal tooth (ra above) and ventrally turned tooth (ra below), with interconnecting radular material (ic) forming symphysis to teeth of right side (photo: G. Haszprunar).
Figura 7. Corte al microscopio de la parte izquierda de la zona anterior de la rádula de Wirenia argentea, *con el diente dorsal (ra, arriba) y el diente torcido ventralmente (ra, debajo), con material de interconexión (ic) formando una sínfisis con los dientes del lado derecho (fotografía G. Haszprunar).*

subepithelial follicles (so-called type A), whereas among Cavibelonia — apart from organs of type A — four additional types are elaborated (SALVINI-PLAWEN, 1972b, 1978). With regard to the radula, Pholidoskepia possess either monoserial or biserial types, whereas Cavibelonia also have polyserial/polystichous radulae.

Investigations on biserial-distichous radulae in some species revealed particular conditions. PRUVOT (1900) points to the development of the distichous radula of *Pruvotina impexa* out of a monoserial anlage. SALVINI-PLAWEN (1978) describes the developmental sequence of the biserial radula of *Plawenia schizoradulata*: it begins with a symphysis (as a U-shaped, monoserial organ), which divides towards the pharynx to become truly biserial. SALVINI-PLAWEN (1988a) demonstrates that the distichous radula of *Wirenia argentea* Odhner, 1921 (syn. *Aesthoherpia glandulosa* S.-Plawen) is interconnected by radula material forming a symphysis (Fig. 7), thus being in truth a monoserial organ without differentiating a real radular membrane (ribbon). In contrast, a basally separated membrane can light-optically be distinguished in Caudofoveata (SCHELTEMA, 1978, SALVINI-PLAWEN, 1981b, DEIMEL, 1982, SCHELTEMA *ET AL.*, 1994). WOLTER (1992) confirms for the investigated Solenogastres (*Genitoconia sp.*, *Wirenia argentea*, *Micromenia fodiens* (Schwabl,1955) and a species of Cavibelonia) the lack of a real ribbon, but states that the Caudofoveata (*Scutopus robustus* S.-Plawen,1970) likewise do not differentiate a true, separated radular membrane, but rather a type of pre-ribbon. The rudimentary ribbon in Solenogastres, however, is

attached to the basis of the teeth by microfibrils that extend into the underlying epithelium. These are lacking in Caudofoveata and Placophora, and the rudimentary membrane of Caudofoveata is linked to older teeth only by fibrillous bundles (WOLTER, 1992, SCHELTEMA *ET AL*., 1994), as is the ribbon in Placophora. In connection with sclerotisation, this condition distinctly simulates in Caudofoveata a light-optically separated ribbon (SALVINI-PLAWEN, 1981b, Wolter, 1992).

All these conditions point to the fact that a monoserial radula, including the biserial-distichous radula with symphysis, represents the most conservative type, only retained in Solenogastres. This is also reflected by computer-processed analyses (see below), according to which the Solenogastres-Pholidoskepia with monoserial radulae represent the basal group. Nearly all Solenogastres are predators on Cnidaria (SALVINI-PLAWEN, 1981b), and they probably retained their conservative midgut due to their carnivorous habit. The different types of radulae (family characters) infer that most of these types are well-suited or even adapted for uptake of cnidarian food, particularly the monoserial and distichous types. Monoserial radulae (without symphysis) are elaborated in Dondersiidae, Macellomeniidae, and (?) Sandalomeniidae (all Pholidoskepia) as well as in Acanthomeniidae and Amphimeniidae (Cavibelonia) (SALVINI-PLAWEN, 1978). In several species, adaptation has led to a fused, unpaired outlet of the ventral foregut glandular organs associated with the radula. These include *Macellomenia* (3 spp.), *Stylomenia* (2 spp.), *Pholidoherpia* (2 spp.), *Sandalomenia*? (2 spp.), two species of *Micromenia* and *Dondersia festiva* Hubrecht, 1888. In contrast, other *Dondersia* (4 spp.), *Micromenia simplex* Leloup,1948, *Nematomenia* (*N. flavens* (Pruvot,1890) and at least five more species), *Lyratoherpia* (2 spp.), *Ichthymenia ichthyodes* (Pruvot, 1890), *Heathia porosa* (Heath,1911), Acanthomeniidae (3 spp.) and Amphimeniidae (23 spp.) still possess the paired outlet of the glandular organs (e.g., PRUVOT, 1891, SALVINI-PLAWEN, 1978, SCHELTEMA, 1999, HANDL AND SALVINI-PLAWEN, 2001, 2003). The distichous type (in general with paired outlet of glandular organs) among Pholidoskepia is elaborated in Gymnomeniidae, Lepidomeniidae and Meiomeniidae. The distichous-biseral type, however, is the predominant one among Solenogastres in general; in some members the radula sheath is even distinctly paired at its proximal end (e.g., *Pruvotina peniculata* in SALVINI-PLAWEN, 1978, *Plawenia sphaera* in SCHELTEMA AND SCHANDER, 2000).

All Caudofoveata definitely possess a distichous radula, though they appear to be mainly micro-omnivores or micro-carnivores. In Chaetodermatidae this nourishment has led to a highly modified radula apparatus that is correlated to a kind of stomach region in the midgut with a protostyle and gastric shield (SCHELTEMA, 1978, SALVINI-PLAWEN, 1981b, 1988a). Such a condition reflects an increasing adaptation to specialised nourishment, moving away from micro-omnivory due to a less suitable distichous radula. This could point to an original carnivory in caudofoveate forerunners.

SIRENKO AND MINICHEV´S (1975) thesis of a monoserial origin of the placophoran radula is questioned by EERNISSE AND KERTH (1988), who underline a paired origin with three teeth at each side. Other molluscs may likewise show paired anlagen or even an initially distichous stage of the radula (KERTH, 1983, EERNISSE AND KERTH, 1988); this led to the assumption that a distichous type might have been the original radula of molluscs. All this supports carnivory as being original in contrast to the hitherto supposed herbivory. Accordingly, the primitive radula served to attack and split open soft-bodied prey. A monoserial elaboration of a midventral, serially chitinised pharyngeal cuticle as firm bars or flexible plates (see symphyses) — at each side elaborated to a definite cusp, denticle or hook — meets the conservatively

retained types in Solenogastres and most likely represented the original radula.

There is no mutuality with respect to the radula support. All Caudofoveata investigated possess a pair of elongate, well-delimited, compact bolsters which consist of muscular and connective tissue, frequently interspersed by turgescent or chondroid cells (e.g., WIREN, 1892, SCHELTEMA 1972). In Solenogastres a radula support frequently is represented only by some accumulation of muscular and connective tissue in median or paired arrangement. More differentiated supports consist of a distinct muscular concentration which may also include or be associated with turgescent cells (e.g., Amphimeniidae, Simrothiellidae; SALVINI-PLAWEN 1978, SCHELTEMA *ET AL.*, 1994). Occasionally (some Simrothiellidae), turgescent cells are very voluminous and distincly arranged or may even be compacted to a pair of muscularly surrounded vesicles. Though such a latter condition resembles the radula vesicles of Placophora and Tryblidia (cf. WINGSTRAND, 1985), the exceptionality in advanced Solenogastres (Cavibelonia) clearly implies analogous similarity.

4. SYSTEMATICS OF SOLENOGASTRES

THIELE´S classification of the Solenogastres (1913) — accepting four families with respect to the mantle cover and the presence/absence of respiratory organs (secondary gills) — had been abandoned by SALVINI-PLAWEN (1967) and replaced by a pure alphabetical order of the genera. Investigating an extensive material, SALVINI-PLAWEN (1978) then proposed a new classification based on the conditions of the mantle cover (orders, supraorders) and the various differentiation of the foregut glands and the radula (families). Accordingly, the representatives with a mantle cover of calcareous scales and of a thin cuticle, the order Pholidoskepia, are regarded as being conservative. They are classified together with the Neomeniamorpha (with thin cuticle and spearlike, grooved mantle bodies, and with a highly complex accessory genital apparatus) as Aplotegmentaria. The small order Sterrofustia (thick cuticle; elongate, solid mantle bodies) and the order Cavibelonia (with acicular, hollow spicules and mostly with a thick cuticle) are classified as Pachytegmentaria. However, some findings raise the possibility that the formation of hollow needles (Cavibelonia) might be polyphyletic (SALVINI-PLAWEN, 1978, SCHELTEMA AND KUZIRIAN, 1991, HANDL AND SALVINI-PLAWEN, 2003).

To assess the phylogenetic interrelationships and evidence for the systematic arrangement of the families of Solenogastres, two character matrices for all genera were prepared and submitted to parsimony searches in PAUP* 4.0b10 (SWOFFORD, 2002). In addition to the Placophora and Caudofoveata, the taxon "Solenogastres" is included, defined by the putative plesiomorphic character states (when evaluable) or by "?" entries. Searches were limited to 750.000 shortest trees (using the command *"set maxtrees"*) and 22 hours (using the *timelimit* option in the command *hsearch*), due to the high number of taxa and resulting trees as well as the limited computational resources. All searches hit the set number of trees, except for the weighted analysis for 53 characters which hit the time limit earlier.

(1) A matrix of 35 characters (1-35 in Tables II and III) at the level of presently accepted families was analyzed using unweighted and weighted parsimony (shortest trees of unweighted analysis: 88 steps, CI=0.3295, RC=0.2792). Both analyses yield largely unresolved strict consensus trees (not shown) with three major polytomies: the genera *Wirenia* and *Genitoconia* (part of Gymnomeniidae); the other Pholidoskepia including the "Solenogastres"; and all remaining advanced taxa. Among the latter, only Amphimeniidae and Rhipidoherpiidae appear monophyletic.

(2) Unweighted parsimony analysis of an enlarged matrix with 53 characters (Tables II and III) returned a similar strict consensus tree as analysis (1) (not shown; shortest trees: 161 steps, CI=0.2609, RC=0.2074). It separates only the Aplotegmentaria and the Pachytegmentaria. The basal Aplotegmentaria consist of a polytomy of 22 branches of Pholidoskepia (including "Solenogastres") with a common line for Gymnomeniidae, Acanthomeniidae, and monophyletic Neomeniamorpha. The advanced level of Pachytegmentaria represents a polytomy of 43 branches (e.g. Simrothiellidae in four lines), including the monophyla Amphimeniidae, Strophomeniidae, and Rhipidoherpiidae.

(3) In contrast, the majority-rule consensus tree (Fig. 8 A) is much better resolved. It separates the "Solenogastres" as the basal-most line from a polytomy of nine branches; seven of these represent most Pholidoskepia with monoserial radulae, one unites the Pholidoskepia with distichous radulae and the monophyletic Neomeniamorpha, and one leads to three dondersiid genera and to the Pachytegmentaria.

(4) The analysis of the 53-character matrix attributing the weight 5 to the characters 18 and 53 (Tables II and III) (shortest trees: 174 steps, CI=0.2874, RC=0.2303) returns an even better resolved majority-rule consensus tree (Fig. 8 B). It shows all Pholidoskepia with monoserial radulae in a basal polytomy, whereas those with distichous radulae are tied to the genera of the Sterrofustia, Neomeniamorpha, and Cavibelonia. Note that in this tree the Neomeniamorpha appear in an advanced position together with cavibelonian and sterrofustian genera.

The low number of characters available at the genus-level permits only limited resolution of the 87 ingroup taxa. First, the Pholidoskepia represent indeed the basal level among Solenogastres. Second, the Pholidoskepia with monoserial radulae appear to be conservative compared with those with distichous radula. Third, the order Neomeniamorpha is confirmed to be monophyletic, though of doubtful relationship. Fourth, a polyphyly of the Cavibelonia is not visible in these trees; rather, a possible polyphyly is indicated for the Sterrofustia. Finally, only two families as presently defined are always monophyletic, the Rhipidoherpiidae and Amphimeniidae. Yet, in most majority-rule-consensus trees of the larger data set (Fig. 8 A, B), also Acanthomeniidae, Gymnomeniidae, Strophomeniidae, Epimeniidae and Proneomeniidae appear monophyletic.

It is evident that the "present: absent" coding (Table III) includes various convergencies (homoplastic characters) and most characters in the trees have low constistency indices (CI < 0.5). In some cases this implies unexpected results. Thus, in Fig. 8A, the lack of the terminal sense organ is a synapomorphy for three dondersiid genera (*Helluloherpia, Ichthyomenia, Heathia*) and brings them in a separate position, whereas the splitting of the Rhopalomeniidae is due to the foregut glands and the radula (in *Dinomenia*). Only the presence of the radula in *Dinomenia* isolates this genus from other Rhopalomeniidae in Fig. 8 B. The division of the Phyllomeniidae refers to the absence of the terminal sense organ in *Lituiherpia* and *Ocheyoherpia*. The latter condition unites these with the pararrhopaliid *Forcepimenia*. The three families, Phyllomeniidae, Pararrhopaliidae and Rhopalomeniidae, however, due to the characters of the mantle cover, the radula and the foregut glands, appear not unexpectedly in an intermediate position between the Pholidoskepia and the derived Cavibelonia (see systematic arrangement in SALVINI-PLAWEN, 1978). These examples demonstrate that the available characters are extremely homoplastic and that homology decisions are far too uncertain to accept the resulting trees as reflections of the phylogeny of the Solenogastres.

5. ANAGENETIC LEVELS IN MOLLUSCA

In view of the two different levels of elaborations of the midgut and the excretory system in Mollusca, the aplacophoran configurations are clearly more conservative than those of the Testaria (see also subradular organ, radular bolster): the respective elaborations express two subsequent evolutionary grades of molluscan organisation. This also holds true for the radula, which in both aplacophoran groups shows a conservative state with a "pre-ribbon" only (KERTH, 1983, WOLTER, 1992). Within Testaria, again two clearly different, subsequent grades are expressed, representing the polyplacophoran and the monoplacophoran (conchiferan) levels; this is also evidenced by cladistic analysis (SALVINI-PLAWEN AND STEINER, 1996, HASZPRUNAR, 2000). On one hand, the aplacophoran groups and Placophora share (as *Aculifera*) several conservative characters such as the chitinous cuticle with sclerites, a supra-rectal commissure, the heart-ventricle as a middorsal invagination of the pericardium and the paired muscle to roll up, or the plesiomorphic organisation of the ciliary apparatus (LUNDIN AND SCHANDER, 2001). On the other hand, Placophora and Tryblidia ("monoplacophorans") are closely interconnected by the almost identical organisation of the radular bolster (WINGSTRAND, 1985) and by the dorsoventral musculature. The monophyly of the monoplacophoran level (Conchifera), in turn, is manifested by the common differentiation of the shell or concha, of statocysts, of a sub-rectal commissure, of jaw plate(s), of a style-sack type of stomach and of cerebrally-innervated appendages (SALVINI-PLAWEN, 1988A, SALVINI-PLAWEN AND STEINER, 1996, HASZPRUNAR, 2000).

The organ system that most clearly demonstrates the evolutionary pathway, however, is the mantle cover and its associated musculature. There is a name-giving, gradual anagenesis of the morphologically dorsal integument (mantle, pallium) from the aplacophoran to the polyplacophoran and to the monoplacophoran (conchiferan) levels. The mantle in Solenogastres and Caudofoveata is homogeneously covered by a chitinous cuticle with embedded, unicellularly formed aragonitic sclerites, such as is also differentiated in the girdle or perinotum of Placophora. Evaluating the different kinds of elaborations shows that squamous elements or scales represent the most conservative types when compared with acicular spicules and other types of sclerites (SALVINI-PLAWEN, 1972a, HAAS, 1981). This common character in aplacophoran and placophoran molluscs is paralleled by the Musculus longitudinalis along the mantle border; it rolls the animals up and is present in Solenogastres (M.l.ventralis) and in some lower Caudofoveata (M.l.ventralis in *Scutopus*) as well as in Placophora (M.l.lateralis; but see HASZPRUNAR AND WANNINGER, 2000). On the other hand, the homogeneously elaborated mantle — underlain by layers of outer transverse, intermediate oblique and inner longitudinal muscle fibres (such as in many other invertebrate groups) — in the aplacophoran level is strutted against the ventral body (foot) by a paired dorsoventral musculature. This is elaborated in an undefined number of serial pairs of two bundles, the dorsal-outer ones intercrossing medioventrally. In Placophora, the integumental musculature is restricted to bundles associated with the eight serial middorsal shell plates, whereas the dorsoventral musculature is concentrated (HASZPRUNAR AND WANNINGER, 2000) and grouped to 16 pairs of three bundles each, the dorsal-outer ones again intercrossing medioventrally. An identical configuration of dorsoventral musculature is present in Tryblidia. Here, however, every two successive bundle groups of the paired series are mostly fused into one common bundle. In the new monoplacophoran (or conchiferan) condition, the dorsoventral musculature is thus represented by eight, in part still subdi-

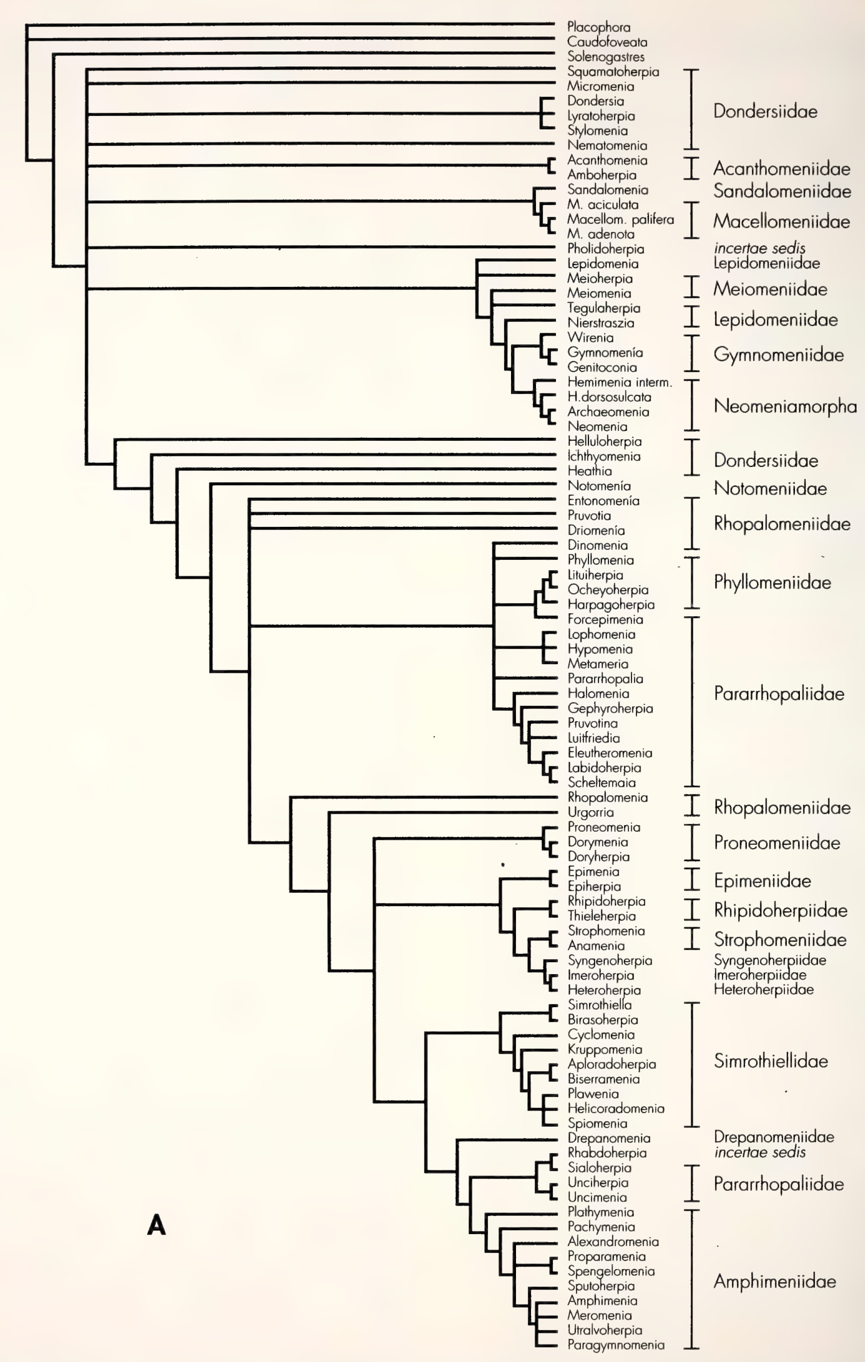


Figure 8. Maximum Parsimony analyses of Solenogastres genera according to 53 morphological characters (see Tables II and III). Note that due to the incongruency and low CI of most characters, these trees do not represent the phylogeny (see text). A: Majority-rule consensus tree of 750,000 most parsimonious trees returned by unweighted parsimony analysis of the 53-character matrix. B: Majority-rule consensus tree of 587.000 most parsimonious trees returned by weighted parsimony analysis of the 53-character matrix (weight 5 for characters 18 and 53).

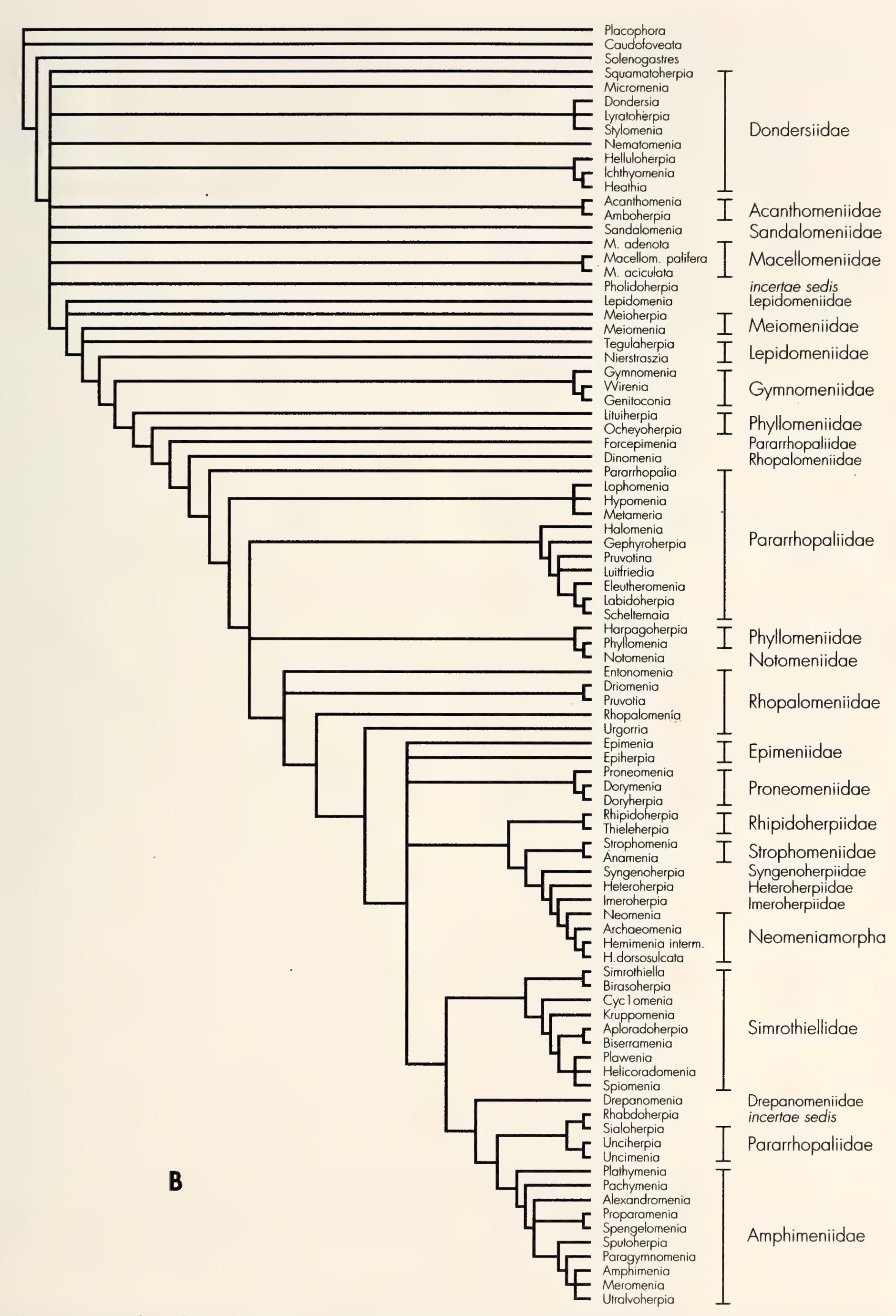


Figura 8. Análisis de máxima parsimonia de generos de Solenogastres según 53 caracteres morfológicos (ver Tablas II y III). Nótese que debido a la incongruencia y al bajo CI de la mayoría de los caracteres, estos árboles no representan la filogenia (ver el texto). A: Árbol de máximo consenso de entre los 750.000 obtenidos por el análisis de parsimonia (misma importancia para todos los caracteres) de la matriz de los 53 caracteres. B: Árbol de máximo consenso de los 587.000 obtenidos por el análisis de parsimonia (peso 5 para los caracteres 18 a 53) de la matriz.

Table II. Characters to matrix in Table II (cf. THIELE, 1913; HOFFMANN, 1929; SALVINI-PLAWEN, 1967, 1972b, 1978, 1985; SCHELTEMA, 1999, 2000; SCHELTEMA AND SCHANDER, 2000; GARCÍA-ÁLVAREZ, URGORRI AND CRISTOBO, 2000; HANDL AND SALVINI-PLAWEN, 2001, 2003).
Table II. Caracteres de la matriz de la Tabla II (cf. THIELE, 1913; HOFFMANN, 1929; SALVINI-PLAWEN 1967, 1972b, 1978, 1985; SCHELTEMA, 1999, 2000; SCHELTEMA Y SCHANDER 2000; GARCÍA-ÁLVAREZ, URGORRI Y CRISTOBO, 2000; HANDL Y SALVINI-PLAWEN, 2001, 2003).

1	Cuticle: thin: 0, thick: 1
2	Shell plates: absent: 0, present: 1
3	Mantle bodies: scales: 0, other: 1
4	Acicular spicules: absent: 0, present: 1
5	Hollow needles: absent: 0, present: 1
6	Mantle bodies: one layer:0, several layers: 1
7	Mantle bodies: hooks absent: 0, hooks present: 1
8	Mantle bodies : spear grooves absent: 0, present: 1
9	Foot: present: 0, absent: 1
10	Ctenidia: present: 0, absent: 1
11	Other respiratory organs: absent: 0, present: 1
12	Osphradia: present: 1, as dtSO: 0
13	Subradular organ: absent: 0, present: 1
14	Midgut: not regionated: 0, regionated: 1
15	Gonoducts: present: 0, absent: 1
16	Aorta: absent: 0, present: 1
17	Sexes: separate: 0, hermaphroditic: 1
18	Ventral foregut glands: present: 0, absent: 1
19	Ventral foregut glands: type A: 0, other: 1
20	Ventral foregut glands: type B: 0, other: 1
21	Ventral foregut glands: type C: 0, other: 1
22	Ventral foregut glands: type D: 0, other: 1
23	Ventral foregut glands: follicular: 0, other: 1
24	Radula: present: 0, absent: 1
25	Radula: monoserial: 0, other: 1
26	Radula: monoserial plates: 0, other: 1
27	Radula: biserial: 0, other: 1
28	Radula: distichous: 0, other: 1
29	Radula: tetraserial: 0, other: 1
30	Radula: polystichous: 0, other: 1
31	Receptacula seminis: absent: 0, present: 1
32	Receptacula seminis: in bundles: 1, other: 0
33	Mucous tract glands; epithelial: 0, subepithelial: 1
34	Copulatory-stylet gland: absent: 0, present: 1
35	Commissural sack organ: absent: 0, present: 1
36	Dorsoterminal sense organ: present: 0, reduced: 1
37	Mouth and atrium: separate: 0, common/fused: 1
38	Copulatory stylets: absent: 0, present: 1
39	Secondary genital opening : paired: 0, single/fused: 1
40	Dorsal papilla foregut gland: absent: 0, present: 1
41	Peripharyngeal glandular organs: absent: 0, present: 1
42	Opening of ventral foregut glandular organs: sub-radular: 0, pre-radular: 1:
43	Midgut: without regular constrictions: 0, serial pouches: 1
44	Paired ventral radula sack: missing: 0, present: 1
45	Distally axe-shaped spicules: missing: 0, present: 1
46	Epidermal papillae: not elaborated: 0, present: 1
47	Buccal ganglia: present: 0, reduced/replaced: 1 (Epimenia)
48	gonoducts proper: present: 0, not elaborated: 1
49	Aorta: not elaborated: 0, present: 1
50	Aesthetes: not elaborated: 0, present: 1
51	Subradular sense organ: not present: 0, present: 1
52	Head-region: not elaborated: 0, separated: 1
53	Nail-formed spicules: absent: 0, present: 1

vided pairs of bundles (LEMCHE AND WINGSTRAND, 1959, SALVINI-PLAWEN, 1969, 1981a, WINGSTRAND, 1985, HASZPRUNAR AND SCHAEFER, 1997a). Beyond this configuration of dorsoventral musculature, the almost identical organisation of the radular support likewise points to the polyplacophoran level as the direct forerunner of the monoplacophoran level by fusion of the eight shell plates towards the concha. This is also paralleled by the Merismoconcha (YU, 1984, SALVINI-PLAWEN, 1991). In higher Conchifera, the dorsovental musculature is even more concentrated (see also fossil Cyrtonellida and Sinuitopsida), resulting in a different number of paired bundles reflecting the shape and functional demands on the shell in each class.

Altogether, the mantle cover, the dorsoventral musculature, and the elaboration of the alimentary tract present successive, overlapping sequences of evolutionary differentiation. Within Mollusca they reflect a distinct, gradual anagenesis from the aplacophoran to the polyplacophoran and monoplacophoran (conchiferan) levels. These evolutionary grades also indicate the direction in which the homology series must be read and defined. This clearly reveals the Solenogastres and Caudofoveata to be early, conservative offshoots of the molluscan organisation (rather than being derived from polyplacophorans). It likewise excludes a monophyly of *Aculifera* (e.g. SCHELTEMA,1996, IVANOV, 1996), which would incorrectly assume the above-presented coincidences in the alimenary tract and the excretory system in Testaria to be convergencies; it also removes most of the potential synapomorphies from the Solenogastres and Caudofoveata (revealing them to be symplesiomorphies).

6. PLESIOMORPHIC CONDITIONS OF MOLLUSCA

The evaluation of plesiomorphic characters in Mollusca and of the original molluscan organisation yealds two results: it summarises the smallest common denominators of features, and it traces the anagenetic conditions back to their most basic elaboration.

Within the conservative level of aplacophoran molluscs, the Caudofoveata exhibit, in some characters, more advanced conditions than Solenogastres. Of particular interest are the protostyle formation in the midgut, an aorta, a radula ribbon and ctenidia — all also present in Testaria. Are these characters synapomorphies or merely convergent autapomorphies in Caudofoveata and Testaria (or simply reduced in Solenogastres) ? Cladistic computer programs, due to their reflection of numerical taxonomy, use the parsimony argument to incorporate them as synapomorphies and make the Solenogastres the earliest offshoot (cf. SALVINI-PLAWEN AND STEINER, 1996, HASZPRUNAR, 2000). The elaboration of a midgut section with a protostyle and gastric shield among Caudofoveata has been verified in the most advanced Chaetodermatidae only, but the functional parallelism of this elaboration is obvious (see also MORTON, 1960, for similar differentiations in other animal groups). Conversely, the adaptive flexibility of the circulatory system throughout Mollusca casts doubt on aorta formation as being a strong synapomorphic character rather than a functionally-tied, convergent differentiation. As outlined above, the light-optically recognized radula membrane in Caudofoveata is a kind of pre-ribbon, but intermediates between the elaborations in Solenogastres and Placophora. This may reflect either a synapomorphic or a convergent differentiation of a true ribbon and thus weakens the argument. With regard to the ctenidia and their characteristic elaborations (see SALVINI-PLAWEN 1981a, 1985, HASZPRUNAR, 1987), they are generally accepted to be a typical molluscan character and hence proposed to be already differentiated in the common forerunners (archimolluscs). Their absence in Solenogastres, either within monophyletic aplacophorans or as a sister-group of Tes-

Table III. Matrix for Figure 8.
Tabla III. Matriz para la Figura 8.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
Placophora	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	?	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0	1	1	1	1	0
Caudofoveata	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1	1	1	1	0	0	1	1	1	0	1	1	0	0	0	0	0	0	?	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Solenogastres	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	?	1	1	1	?	0	0	1	1	1	1	1	?	0	0	0	0	0	0	0	0	0	0	0	?	0	0	0	0	0	0	0	0	0	0
Dondersia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Micromenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stylomenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Lyratoherpia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Nematomenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	1	0	1	?	0	0	0	0	0	0	0	0	0	0	0	0	0
Ichthyomenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Heathia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Squamatoherpia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helluloherpia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sandalomenia	0	0	0	0	0	0	0	0	0	1	?	0	0	0	1	0	1	0	?	?	1	1	1	0	?	0	?	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnomenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	1	1	1	0	0	1	1	1	0	1	1	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Wirenia	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	1	0	0	1	1	1	0	1	1	1	0	0	0	1	0	1	1	?	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Genitoconia	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	1	0	0	1	1	1	0	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidomenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tegulaherpia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nierstraszia	0	0	0	0	0	0	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Meiomenia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	?	0	1	1	?	?	0	0	0	0	0	0	0	0	0	0	0	0	0
Meioherpia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	?	0	1	0	?	?	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholidoherpia	0	0	0	0	0	0	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	?	?	0	?	0	0	1	?	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macellom palifera	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0	0	?	0	1	0	0	0	?	0	0	0	0	0	0	0	0	0	1
M aciculata	0	0	0	0	0	0	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	0	0	?	0	0	0	0	0	0	0	0	0	1
M adenota	0	0	0	0	0	0	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	?	0	0	0	0	?	0	0	?	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Archaeomenia	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1	0	0	1	0	0	1	1	0	0	0	?	1	0	0	0	0	0	0	0	0	0	0
Hemimenia interm	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	1	0	?	1	1	1	0	0	?	1	0	0	0	0	0	0	0	0	0	0
H dorsosulcata	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	1	0	0	1	1	0	0	0	?	1	0	0	0	0	0	0	0	0	0	0
Neomenia	1	0	0	1	0	0	0	1	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	1	0	0	1	1	?	0	0	?	1	0	0	1	0	0	0	0	0	0	0
Imeroherpia	1	0	1	1	0	1	0	0	0	1	1	0	0	0	1	0	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	0	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Phyllomenia	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0
Harpagoherpia	1	0	1	1	0	1	?	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	?	0	0	1	0	0	0	0	0	0	?	0	0	0	0	0	0	0
Lituiherpia	1	0	0	1	0	1	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	1	1	0	1	0	0	0	1	0	0	?	0	0	0	0	0	0	0
Ocheyoherpia	1	0	1	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	?	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Heteroherpia	1	0	1	1	0	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Rhabdoherpia	1	0	1	1	0	1	0	0	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	0	0	1	0	0	?	1	0	0	1	0	0	0	0	0	0	0
Notomenia	1	0	1	0	0	0	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	?	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Pararrhopalia	1	0	1	1	1	?	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Pruvotina	1	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Labidoherpia	1	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Eleutheromenia	1	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Gephyroherpia	1	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Luitfriedia	1	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	1	?	?	1	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	?	0	0	1	0	0	0	0	0	0	0
Lophomenia	1	0	1	1	1	?	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	?	0	0	1	0	0	0	0	0	0	0
Metameria	1	0	1	1	1	?	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Hypomenia	1	0	1	1	1	?	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	0	?	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Halomenia	1	0	1	1	1	?	0	0	0	1	1	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Forcepimenia	0	0	1	1	1	?	0	0	0	1	?	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	?	0	0	0	0	1	0	?	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Scheltemaia	1	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	0	1	1	1	1	1	0	1	1	1	0	1	1	0	0	0	0	1	0	1	1	1	0	0	0	?	0	0	?	0	0	0	0	0	0	0
Unciherpia	0	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	1	0	1	0	1	?	1	0	0	1	0	0	0	0	0	0	0
Uncimenia	0	0	1	1	1	?	1	0	0	1	1	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	1	0	1	0	1	?	1	0	1	1	0	0	0	0	0	0	0
Sialoherpia	1	0	1	1	1	?	0	0	0	1	?	0	0	0	1	0	1	1	1	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	0	?	1	0	1	?	1	0	0	1	0	0	0	0	0	0	0
Rhopalomenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Entonomenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Dinomenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Driomenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	?	?	?	?	?	?	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Pruvotia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	?	?	?	?	1	1	?	?	?	?	?	?	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Urgorria	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	1	?	?	?	?	?	?	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0

Table III. Continuation.
Tabla III. Continuación.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
Acanthomenia	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	1	?	0	0	0	0	?	1	?	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amboherpia	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	?	1	1	1	?	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphimenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	?	0	1	0	0	1	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Proparamenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	1	1	0	1	0	0	1	?	0	0	1	0	0	0	0	0	0	0
Pachymenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1	1	?	?	?	?	?	?	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
Alexandromenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
Spengelomenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	1	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
Paragymnomenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Plathymenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	1	0	1	1	?	?	?	?	?	?	1	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Sputoherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
Utralvoherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Meromenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	1	0	1	0	0	0	?	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Simrothiella	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	?	0	0	0	0	0	1	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0
Kruppomenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cyclomenia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plawenia	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Spiomenia	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	1	1	1	0	0	0	?	1	1	0	0	0	0	0	0	0	0
Birasoherpia	1	0	1	1	1	1	0	0	0	1	1	0	0	0	1	0	1	?	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	0	0	?	1	1	0	1	0	0	0	0	0	0	0
Aploradoherpia	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	?	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biserramenia	1	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helicoradomenia	1	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	0	1	1	1	1	0	0	0	0	0	1	1	1	?	0	0	1	1	0	?	0	0	0	0	0	0	0
Drepanomenia	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	1	?	?	?	?	?	?	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Strophomenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	1	1	1	?	?	?	?	?	?	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Anamenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Proneomenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Dorymenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Doryherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	0	?	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Epimenia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0
Epiherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	?	?	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Syngenoherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	1	1	1	0	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Rhipidoherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	1	1	0	1	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Thieleherpia	1	0	1	1	1	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	0	1	1	1	1	1	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0

taria, was thus regarded as a secondary loss related to the reorganisation of the mantle cavity. Yet, computer-processed cladistics (SALVINI-PLAWEN AND STEINER, 1996, HASZPRUNAR, 2000) and the fairly conservative condition in several characters (radula, midgut, circulatory and excretory systems, musculature, larvae) points to the Solenogastres as being an offshoot of the earliest evolutionary level of molluscs. This conservative condition could likewise have included the lack of ctenidia; this is supported by the obvious need of many Solenogastres to differentiate respiratory organs, which have not been verified as (recapitulated) ctenidia. The innervation, however, could provide a counterargument: The innervation of the mantle cavity organs from the suprarectal commissure is almost identical in Solenogastres, Caudofoveata and Placophora (SALVINI-PLAWEN, 1981a, HASZPRUNAR, 1987). Apart from the dorsoterminal/osphradial sense organ, this also includes the ctenidia in Caudofoveata and — multiplied — in Placophora. A respective innervation pattern of the frontal portion of the spawning ducts in Solenogastres could indicate an original presence of ctenidia prior to their loss due to the reorganisation (internalisation) of the mantle cavity.

A similarly ambivalent character is the gono-pericardioducts, i.e. aplacophoran molluscs lack proper gonoducts. Is this a plesiomorphy, a synapomorphy of both groups, or analogy? As

is known from development, the differentiation of gonads as a rostral elongation of the pericardium, with retroperitoneal incorporation of the primary germ cells, appears to be a key character of Mollusca (gono-pericardium). The same conditions are found, e.g., in Siphonopoda ("cephalopods") and Bivalvia-*Anodonta*, which retain the interconnection between pericardium and gonads. In addition, the late anlage of separate gonducts (apart from pericardioducts) in Placophora and Siphonopoda-Coleoida (HIGLEY AND HEATH, 1912, HOFFMANN, 1937), as well as the variable gonoduct formation in Conchifera (RAVEN, 1958), suggest that the gonoducts are relatively young or new differentiations (with genetically weak determination), and may be polyphyletic among Testaria. Accordingly, the configuration in both Solenogastres and Caudofoveata could represent a true plesiomorphy (not yet developed gonoducts) or a paedomorphy (retention of developmental stage). The presence of true gonoducts in Solenogastres-*Phyllomenia*, due to the much altered configuration of the pericardioducts and spawning ducts (cf. SALVINI-PLAWEN, 1978), could represent a specialisation (autapomorphy) within that genus; it is thus *per se* not conclusive (see also Haszprunar, 1992). Yet, the possible secondary loss of gonoducts in Solenogastres-*Driomenia* (HEATH, 1911, HOFFMAN, 1949) lends weight to the *Phyllomenia* argument. If, on the other hand, the lack of gonoducts is truly a secondary loss (as more generally assumed), due to the independently narrowed body in Solenogastres and Caudofoveata, this reduction would then reflect analogously acquired adaptations or parallelism (rather than a synapomorphy).

The narrow, ciliated pericardioducts of Caudofoveata often unite abruptly via a sunken opening into the paired glandular duct or sack (e.g., HEATH, 1905: 721); only the latter are connected to the mucous tracts of the mantle cavity, into which they open ventrolaterally by means of a sphincter. These glandular organs often extend beyond the pericardioduct opening (SALVINI-PLAWEN, 1972a), be it rostrally (e.g., *Prochaetoderma californicum* Schwabl, 1963) or dorsally (e.g., *Scutopus robustus*; Fig. 2); in immature *Scutopus ventrolineatus* S.-Plawen,1968, the glandular sacks show a dorsoventral extension, with the sunken pericardioduct openings located centrally. In contrast, the pericardioducts in many Chaetodermatidae open axially into the dorsoterminally bent glandular ducts. Due to our lack of information on organogenesis, the homology of these glandular ducts remains unclear. With respect to their totally different histology (HEATH, 1905, 1911, SALVINI-PLAWEN, 1972a, SCHELTEMA *ET AL.*, 1994), to the often sunken opening of the pericardioducts, and to the anterior extension beyond this opening, the glandular ducts do not appear to be part of the mesodermal pericardioducts. According to their position (see Fig. 2), they would more probably represent a rostral, internalised portion of a formerly paired mantle groove (devoid of mucous tracts). However, their own lateroventral (instead of frontal) opening into the mucous tracts, and the elaboration of these openings as narrow pores with a distinct sphincter, makes such an interpretation dubious. This also holds true for the exceptional configuration in *Prochaetoderma californicum*, in which the mucous tracts form tubes being closed up from the medial mantle cavity (SALVINI-PLAWEN, 1972a: Abb. 27F). Alternatively, the glandular ducts could be remains of the original gonoducts into which the pericardioducts opened to form a common outlet. This interpretation (HOFFMANN, 1937, SALVINI-PLAWEN, 1972a) suffers from the condition that such common outlets in various bivalves and gastropods are generally characterised by the openings of gonoducts into lower pericardioducts (excretory organ or duct), rather than pericardioducts into lower gonoducts.

Hermaphroditism is characteristic for Solenogastres and Gastropoda-Euthyneura, though it also occurs in other molluscan groups (not known in

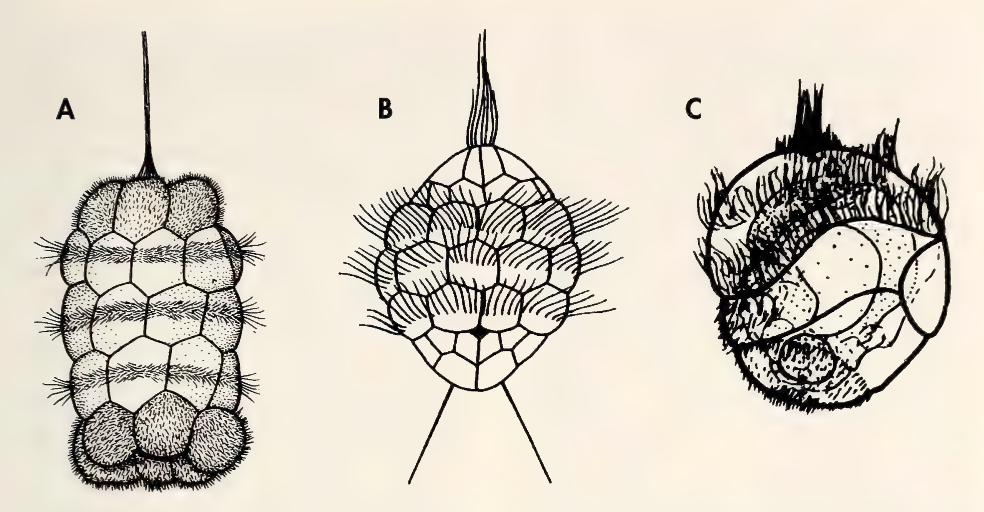


Figure 9. Preoral trochi (prototrochs) in Bivalvia. A: pericalymma larva of *Yoldia limatula* with three trochi (from DREW, 1901); B stenocalymma larva of *Mactra chinensis* (ventral view) with three trochi (from MEDVEDEVA AND MALAKHOV, 1983); C pseudotrochophora (praeveliger) larva of *Pandora inaequivalis* (lateral view) with two trochi (after ALLEN,1961).
Figura 9. Cilios preorales (prototrocas) en Bivalvia. A: larva pericalymma de Yoldia limatula *con 3 hileras de cilios (de DREW, 1901); B: larva estenocalymma de* Mactra chinensis *(vista ventral) con tres hileras de cilios (tomado de MEDVEDEVA Y MALAKHOV, 1983); C: larva pseudotrocófora (preveliger) de* Pandora inaequivalis *(vista lateral) con dos hileras de cilios (de ALLEN, 1961).*

Caudofoveata and Siphonopoda/ cephalopods). Among organisms with separate sexes, free external fertilisation in the open water appears to be primitive, conservatively also correlated with so-called ect-aquasperms ("head" of short nucleus with conical acrosomal vesicle and 4-5 round proximal mitochondria, a diplosome and abruptly separated flagellum). Internal fertilisation implies alteration of sperm organisation and shape (introsperm). Once specialised, no reversal to aquasperm is possible. This also holds true if separate sexes are secondarily acquired; a case in point are the Microhedylidae (Gastropoda-Opisthobranchia-Acochlidiomorpha), which use spermatophores (summarised by E.Wawra in ARNAUD, POIZAT AND SALVINI-PLAWEN, 1986). Caudofoveata and Placophora possess somewhat modified aquasperms, whereas the hermaphroditic Solenogastres exhibit highly derived introsperms (SCHELTEMA *ET AL.*, 1994, HEALY, SCHAEFER AND HASZPRUNAR, 1995). As evidenced by the outgroup comparison (cf. HEALY *ET AL.*, 1995), the hermaphroditism and introsperms of Solenogastres clearly appear to be autapomorphies for this class.

The larval development of lower groups within molluscan classes (apart from Siphonopoda/cephalopods) includes lecithotrophic trochus larvae (SALVINI-PLAWEN, 1980, 1991; HASZPRUNAR, SALVINI-PLAWEN AND RIEGER, 1995). Among these, Solenogastres show the pericalymma and stenocalymma types (SALVINI-PLAWEN, 1991, OKUSU, 2002) and Caudofoveata the stenocalymma type (SALVINI-PLAWEN, 1991, NIELSEN, 1995). Both these types are also present in lower Bivalvia (Fig. 9), and stenocalymma in Scaphopoda, whereas the larvae of Placophora and most Archaeogastropoda (without larval shell) possess the pseudotrochophora or praeveliger type only (FIORONI, 1982, SALVINI-PLAWEN, 1991, HASZPRUNAR *ET*

AL., 1995). Larvae, however, are ecologically-conditioned and many are provided with a trochus or other similar features. Unfortunately, this had led such larvae to be inaccurately termed "trochophorae" (ROUSE, 1999). Not only is this in contrast to the original definition (HATSchek, 1891), but it disregards the detailed morphological differences necessary for homologisation (SALVINI-PLAWEN, 1980), i.e. neglecting analogies (see also HASZPRUNAR, 1995). Note that all known Solenogastres larvae possess one preoral trochus only. In constrast, other free-living pericalymma and stenocalymma types of Caudofoveata, Bivalvia and Scaphopoda exhibit three preoral trochi (NIELSEN, 1995, OKUSU, 2002). Based on the sequence of pericalymma (*Nematomenia, Neomenia*, etc.) to stenocalymma (*Epimenia*) in Solenogastres and Bivalvia (Fig. 9), and even an individual transition from pericalymma to stenocalymma in *Epimenia* (Solenogastres-Cavibelonia; OKUSU, 2002), the pericalymma type appears to be the conservative one (rather than the pseudotrochophora type). The outgroup comparison (SALVINI-PLAWEN, 1980, HASZPRUNAR *ET AL.*, 1995) supports this view.

There are only few, more general developmental coincidences between Mollusca and Coelomata (spiral cleavage, endomesoblast 4d, trochus larvae of pericalymma rather than "trochophora" type; SALVINI-PLAWEN, 1988b); such coincidences do not pertain, however, to the configuration of the body cavity.The formerly heavily discussed theory of a coelomate nature and metameric segmentation in Mollusca, renewed with the one-sided interpretation of Trybidia organisation (LEMCHE AND WINGSTRAND 1959), is now obsolete (SALVINI-PLAWEN, 1969, 1981a, 1988b, SALVINI-PLAWEN AND BARTOLOMAEUS, 1995, HASZPRUNAR AND SCHAEFER 1997a, HASZPRUNAR AND WANNINGER, 2000). The dorsoventral musculature in Placophora, arranged in 16 pairs of bundles, ontogenetically differentiates from a multiple serial condition similar to that in recent Solenogastres, and the anterior (pre-trochal) musculature recapitulates a "worm-grid" (HASZPRUNAR AND WANNINGER, 2000). Moreover, the developmental fate of the (endo-) mesoblastema in Placophora (musculature, pericardium) and spiralian Coelomata (secondary body cavity, musculature) is distinctly different (SALVINI-PLAWEN AND BARTOLOMAEUS, 1995), negating any mutual dependence of the derivates. Underlined by the organisation of Solenogastres (SALVINI-PLAWEN AND BARTOLOMAEUS, 1995), the molluscan forerunners most logically originated from epifaunal, ciliary-gliding mesenchymate to pseudo-coelomate Spiralia (TRUEMAN, 1976).

With regard to the plesiomorphic conditions of Mollusca, the comparative consideration of the two diphyletic recent taxa of paraphyletic *Aplacophora* clearly helps to outline the probable original organisation of molluscs (archimolluscs). This, in turn, provides a common base for understanding the subsequent phylogenetic radiation. The plesiomorphies include (comp. also SALVINI-PLAWEN, 1972a, 1981a, 1985, 1991, HASZPRUnar, 1992):

- A dorsoventrally constructed body with separation into a ventral locomotory surface in the form of a ciliary gliding sole (foot) and a dorsal protective surface (mantle); the latter secretes a chitinous cuticle as well as unicellularly formed, squamous calcareous sclerites (aragonitic scales).
- Foot and mantle at least in posterior part of body separated by a peripedal groove (pallial cavity) with body outlets, high glandular mucous tracts and (?) one pair of ctenidia.
- A paired chemoreceptive (osphradial) sense organ between the terminal mantle rim and pallial cavity, innervated from the suprarectal commissure.
- An amphineurous nervous system consisting of a paired cerebral ganglion, buccal ring and two pairs of medullary body nerve cords irregularly interconnected by ventral (pedal) commissures and lateroventral connectives; lateral cords with suprarectal commissure.
- A subintegumental musculature below the mantle consisting of outer

transverse, intermediate oblique and inner longitudinal fibres, the latter reinforced lateroventrally below the lateral rim of the mantle.

• Without segmentation, but with serially arranged dorsoventral musculature of two pairs of bundles between mantle and foot, the dorsal-outer ones intercrossing medioventrally.

• An alimentary tract only subdivided into foregut and body-filling midgut without separate gland organ(s).

• A monoserial radula formed of serially-midventrally chitinised pharyngeal cuticle and consisting of firm or flexible plates, at both sides each with lateral cusp, denticle or hook; not yet differentiated radula membrane (ribbon).

• Associated with the radula, a paired glandular organ of subepithelial follicles (without paired duct?).

• A suprarectal pericardium with middorsal heart invagination having a single ventricle and a paired auricle (atrium), the latter also performing ultrafiltration (for the primary urine).

• A mesenchymate-pseudocoelomate body cavity with an open circulatory system without aorta.

• Paired pericardioducts without excretory function (no formation of secondary urine).

• A paired gonad differentiated and separated as a rostral enlargement of the pericardium (gono-pericardium); type of gonadial outlets not yet clarified.

• Sexes separate, free fertilisation by means of aquasperms.

• Spiral cleavage

• Indirect development through lecithotrophic trochus larvae of pericalymma type.

• Epibenthic carnivores feeding on more or less immobile, soft-bodied prey.

CONCLUSIONS

A serious, comparative consideration of the aplacophoran molluscs, despite the limited state of knowledge, reveals much important information, particularly with respect to the phylogenetic discussion. Their organisation, especially the different elaborations of mantle cavity organs, clearly reflects the presence of two distinct taxa, the Solenogastres (neomeniomorphs) and the Caudofoveata (chaetodermomorphs). They evolved as diphyletic clades from the common molluscan bed (archimolluscan stem group), which clearly belonged to the aplacophoran level. Thus, *Aplacophora* is paraphyletic, also including the common molluscan ancestors, and the coincidences between the diphyletic Solenogastres and Caudofoveata appear to reflect mere symplesiomorphies. The relative position of both these taxa to the Testaria, however, still remains to be clarified. In any case, characters of the recent Solenogastres and Caudofoveata must be taken into consideration when seriously discussing molluscan plesiomorphies and the archimolluscan organisation.

The characters treated above point to originally mesenchymate-pseudocoelomate organisms with epifaunal, ciliary locomotion; these ancestors most probably nourished themselves as carnivores on soft-bodied, fairly sessile prey (rather than having been algae-scraping herbivores). Such an acoelomate, ciliary-gliding organisation clearly points to an origin from a likewise ciliary-gliding group of organisms with spiral cleavage (possibly close to kamptozoan tholophora larvae; SALVINI-PLAWEN, 1980; HASZPRUNAR *ET AL.*, 1995, HASZPRUNAR, 1996, 2000); these organisations subsequently differentiated molluscan characters (dorsal protective cover, mantle cavity, heart within pericardium, radula). There is no indication at all that the molluscan ancestors had a coelomate organisation (i. e. with secondary body cavity). The pericardium and subsequent gono-pericardium appears to be an autapomorphic adaptation for the new heart, which served for body-fluid circulation and ultrafiltration, i.e. to compensate a restricted distribution of metabolites due to the novel mantle cover and the concentration of gas exchange at the posterior body (mantle

cavity). In contrast, the common stock of related coelomate Spiralia most probably originated as a sister-group by acquiring a secondary body cavity: emerging from the same acoelomate ciliary-gliding forerunners, they adapted to an infaunal, burrowing habit (CLARK, 1964). The rounding up of the body yielded a worm-shaped form with loss of ciliation, which was subsequently followed by the autapomorphic formation of a body-filling hydrostatic coelom, i.e. the secondary body cavity. (Among such monophyletically evolved coelomate Spiralia, the sipunculids with their benthosphaera larvae may perhaps have retained conservative traits; SALVINI-PLAWEN, 1988b, SCHELTEMA, 1996, SALVINI-PLAWEN AND STEINER, 1996, BOORE AND STATON, 2002.)

ACKNOWLEDGEMENTS

The author thanks Dr. Jesús S. Troncoso (Univ. Vigo/Spain)) for the invitation to give this contribution at the II CISME in Vigo (Sept. 9th, 2002). He is also very grateful to Dr. Gerhard Steiner (Univ. Wien/Austria) for computer processing the character matrix of Tables II and III.

BIBLIOGRAPHY

ALLEN, J. A., 1961. The development of *Pandora inaequivalis* (Linné). *Journal of Embryology and experimental Morphology*, 9: 252-268.

ANDREWS, E. B., 1981. Osmoregulation and excretion in prosobranch Gastropods, part 2: structure in relation to function. *Journal of Molluscan Studies*, 47: 248-289.

ANDREWS, E. B., 1988. Excretory systems of Molluscs. *The Mollusca* (Academic Press), 11 (Form and Function): 381-448.

ARNAUD, P. M., POIZAT, Cl. and SALVINI-PLAWEN, L. v., 1986. Marine interstitial Gastropoda (including one freshwater interstitial species). In Botosaneanu, L. (Ed.): *Stygofauna Mundi*. (E. J. Brill/W. Backhuys, Leiden), 153-176.

BABA, K., 1938. The later development of a solenogastre, *Epimenia verrucosa* (Nierstr.). *Journal of the Department of Agriculture Fukuoka*, 6: 21-40.

BOETTGER, C. R., 1956. Beiträge zur Systematik der Urmollusken (Amphineura). *Zoologischer Anzeiger Supplement*, 19: 223-256.

BOORE, J. L. AND STATON, J. L., 2002. The mitochondrial genome of the sipunculid *Phascolopsis gouldii* supports its association with Annelida rather than Mollusca. *Molecular Biology and Evolution*, 19: 127-137.

CLARK, R., 1964. *Dynamics in metazoan Evolution: the Origin of the coelom and segments*. Clarendon Press, Oxford; 131 pp.

DEIMEL, K., 1982. Zur Ableitung des Radulaapparates der Chaetodermatidae (Mollusca, Caudofoveata). *Zeitschrift für zoologische Systematik und Evolutionsforschung*, 20: 177-187.

DREW, G. A., 1901. The life-history of *Nucula delphinodonta*. *Quarterly Journal of microscopical Science*, 44: 313-391.

EERNISSE, D. E. AND KERTH, K., 1988. The initial stages of radular development in chitons (Mollusca: Polyplacophora). *Malacologia*, 28: 95-103.

FIORONI, P., 1982. Larval organs, larvae, metamorphosis and types of development of Mollusca — a comprehensive review. *Zoologisches Jahrbuch für Anatomie und Ontogenie der Tiere*, 18: 375-420.

FISCHER-PIETTE, E. AND FRANC, A., 1960. Classe des Aplacophores. *Traité de Zoologie* (P. P. Grassé), 5 (2): 1655-1700.

GARCÍA-ÁLVAREZ, O., URGORRI, V. AND CRISTOBO, F. J., 2000. Synopsis of the interstitial Solenogastres (Mollusca). *Argonauta*, 14: 27-37.

GEGENBAUR, C., 1878. *Grundriß der vergleichenden Anatomie*. (2nd. ed.; W. Engelmann, Leipzig): 655 pp.

GRAFF, L., 1877. *Neomenia* und *Chaetoderma*. *Zeitschrift für wissenschaftliche Zoologie*, 28: 557-570.

HAAS, W., 1981. Evolution of calcareous hardparts in primitive Molluscs. *Malacologia*, 21: 403-418.

HANDL, Cl. H. AND SALVINI-PLAWEN, L. v., 2001. New records of Solenogastres-Pholidoskepia (Mollusca) from Norwegian fjords and shelf waters including two new species. *Sarsia*, 86: 367-381.

HANDL, Cl. H. AND SALVINI-PLAWEN, L. v., 2003. New records of Solenogastres-Cavibelonia (Mollusca) from Norwegian fjords and shelf waters including three new species. *Sarsia*, 87: 423-450.

HASZPRUNAR, G., 1987. The fine morphology of the osphradial sense organs of the Mollusca. III. Placophora and Bivalvia. *Philosophical Transactions of the Royal Society London, B* 315: 37-61.

HASZPRUNAR, G., 1992. The first molluscs – small animals. *Bollettino Zoologico*, 59: 1-16.

HASZPRUNAR, G., 1995. On the evolution of larval development in the Gastropoda, with special reference to larval planktotrophy. *CISMA* (Roma), XVI: 5-13.

HASZPRUNAR, G., 1996. The Mollusca: coelomate turbellarians or mesenchymate annelids? *Origin and evolutionary radiation of the Mollusca* (J. Taylor edit., Oxford. Univ. Press): 1-28.

HASZPRUNAR, G., 2000. Is the Aplacophora monophyletic? A cladistic point of view. *American Malacological Bulletin*, 15: 115-130.

HASZPRUNAR, G., SALVINI-PLAWEN, L. v. AND RIEGER, R., 1995. Larval planktotrophy - a primitive trait in the Bilateria? *Acta Zoologica (Stockholm)*, 76: 141-154.

HASZPRUNAR, G. AND SCHAEFER, K., 1997a. Anatomy and phylogenetic significance of *Micropilina arntzi* (Mollusca, Monoplacophora, Micropilinidae fam. Nov.). *Acta Zoologica (Stockholm)*, 77: 315-334.

HASZPRUNAR, G. AND SCHAEFER, K., 1997b. Monoplacophora. *Microscopic anatomy of Invertebrates, 6B (Mollusca II)*: 415-457.

HASZPRUNAR, G. AND WANNINGER, A., 2000. Molluscan muscle systems in development and evolution. *Journal of zoological Systematic and evolutionary Research*, 38: 157-163.

HATSCHEK, B., 1891. *Lehrbuch der Zoologie.* 3. Lief.: 305-432. G. Fischer, Jena.

HEALY, J. M., SCHAEFER, K. AND HASZPRUNAR, G., 1995. Spermatozoa and spermatogenesis in a monoplacophoran mollusc, *Laevipilina antarctica*: ultrastructure and comparison with other Mollusca. *Marine Biology*, 122: 53-65.

HEATH, H., 1905. The morphology of a Solenogastre. *Zoologisches Jahrbuch für Anatomie und Ontogenie der Tiere*, 21: 703-734.

HEATH, H., 1911. Reports on the scientific results of the expedition to the tropical Pacific, XIV. The Solenogastres. *Memoirs of the Museum of Comparative Zoology of the Harvard College*, 45 (1): 1-182.

HIGLEY, R. AND HEATH, H., 1912. The development of the gonad and gonoducts in two species of chitons. *Biological Bulletin*, 22: 94-97.

HOFFMAN, S., 1949. Über das Integument der Solenogastren, nebst Bemerkungen über die Verwandtschaft zwischen den Solenogastren und Placophoren. *Zoologisk Bidragen från Uppsala*, 27: 293-427.

HOFFMANN, H., 1929. Amphineura (I). *Bronns Klassen und Ordnungen des Tierreichs*, 3, Abt. 1, Suppl.: 1-368.

HOFFMANN, H., 1930. Amphineura (II.). *Bronns Klassen und Ordnungen des Tierreichs*, 3, Abt. 1, Suppl.: 369-453.

HOFFMANN, H., 1934. *Gastropoda. Handwörterbuch der Naturwissenschaften* (2nd ed), IV: 690-714.

HOFFMANN, H., 1937. Über die Stammesgeschichte der Weichtiere. *Zoologischer Anzeiger Supplement*, 10: 33-69.

HYMAN, L., 1967. *Mollusca I. The Invertebrates* (McGraw-Hill, New York) VI: 792 pp.

IHERING, H. v., 1876. Versuch eines natürlichen Systems der Mollusken. *Jahrbuch der deutschen malakologischen Gesellschaft*, 3: 97-148.

IVANOV, D., 1996. Origin of Aculifera and problems of monophyly of higher taxa in Molluscs. *Origin and evolutionary radiation of the Mollusca* (J. Taylor edit., Oxford. Univ. Press): 59-65.

KERTH, K., 1983. Radulaapparat und Radulabildung der Mollusken. *Zoologisches Jahrbuch für Anatomie und Ontogenie der Tiere*, 110: 205-269.

LANKESTER, E. R., 1883. Mollusca. *Encyclopaedia Britannica* (9th ed.), 9: 632-695.

LEMCHE, H. AND WINGSTRAND, K., 1959. The anatomy of *Neopilina galatheae* Lemche, 1957 (Mollusca, Tryblidiacea). *Galathea Report*, 3: 9-72.

LUNDIN, K. AND SCHANDER, CH., 2001. Ciliary ultrastructure of neomeniomorphs (Mollusca, Neomeniomorpha = Solenogastres). *Invertebrate Biology*, 120: 342-349.

MEDVEDEVA, L. A. AND MALAKHOV, V. V., 1983. Embryogenesis of a bivalve *Mactra chinensis* (Cardiida, Mactridae). *Zoologicheskii Zhurnal*, 62 (8): 1162-1169. (in Russian).

MIZZARO-WIMMER, M. AND SALVINI-PLAWEN, L. v., 2001. *Praktische Malakologie (Practical Malacology)*. Springer-Verlag, Wien/New York; 187 pp.

MORSE, M. P. AND REYNOLDS, P. D., 1996. Ultrastructure of the heart-kidney complex in smaller classes supports symplesiomorphy of molluscan coelomic characters. *Origin and evolutionary radiation of the Mollusca* (J. Taylor Edit., Oxford. Univ. Press): 89-97.

MORTON, J. E., 1960. The functions of the gut in ciliary feeders. *Biological Reviews*, 35: 92-140.

NIELSEN, C., 1995. *Animal evolution.* Oxford Univ. Press; 467 pp.

NIERSTRASZ, H., 1910. Die Amphineuren III. Die verwandtschaftlichen Beziehungen der Solenogastren und Chitonen. *Ergebnisse und Fortschritte der Zoologie*, 2: 414-430.

ØKLAND, S., 1980. The heart ultrastructure of *Lepidopleurus asellus* (Spengler) and *Tonicella marmorea* (Fabricius) (Mollusca: Polyplacophora). *Zoomorphology*, 97: 1-19.

ØKLAND, S., 1982. The ultrastructure of the heart complex in *Patella vulgata* L. (Archaeogastropoda, Prosobranchia). *Journal of Molluscan Studies*, 48: 331-341.

OKUSU, A., 2002. Embryogenesis and development of *Epimenia babai* (Mollusca Aplacophora). *Biological Bulletin*, 203: 87-103.

PELSENEER, P., 1890. Sur le pied de *Chitonellus* et des Aplacophora. *Bulletin scientifique de France et Belgique*, 22: 489-495.

PELSENEER, P., 1906. *Mollusca. A Treatise on Zoology* (E. R. Lankester ed.), 5: 1-65.

PRUVOT, G., 1891. L´organisation de quelques Néoméniens des côtes de France. *Archives de Zoologie expérimentale générale (série 2)*, 9: 699-810.

PRUVOT, G., 1900. La Paraménie. *Zoologie descriptive*, 2 (28): 309-342.

PRUVOT, G., 1892. Sur l´embryogénie d´une *Proneomenia. Comptes Rendues de l´Académie de Science Paris*, 114: 1211-1214.

RAVEN, CH., 1958. The analysis of molluscan development. *Morphogenesis (London)*, 2: 1-311.

REYNOLDS, P. D., 1990. Fine structure of the kidney and characterization of secretory products in *Dentalium rectius* (Mollusca, Scaphopoda). *Zoomorphology*, 110: 53-62.

REYNOLDS, P. D., MORSE, M. P. AND NORENBURG, J., 1993. Ultrastructure of the heart and pericardium of an aplacophoran mollusc (Neomeniomorpha): evidence for ultrafiltration of blood. *Proceedings of the Royal Society London*, B 254: 147-152.

ROUSE, G. W., 1999. Trochophore concepts: ciliary bands and the evolution of larvae in spiralian Metazoa. *Biological Journal of the Linnean Society*, 66: 411-464.

RUPPERT, E. AND SMITH, R., 1988. The functional organization of filtration nephridia. *Biological Review*, 63: 231-258.

SALVINI-PLAWEN, L. v. 1967. Kritische Bemerkungen zum System der Solenogastres (Mollusca, Aculifera). *Zeitschrift für zoologische Systematik und Evolutionsforschung*, 5: 398-444.

SALVINI-PLAWEN, L. v., 1969. Solenogastres und Caudofoveata (Mollusca, Aculiferas): Organisation und phylogenetische Bedeutung. *Malacologia*, 9: 191-216.

SALVINI-PLAWEN, L. v., 1971. Schild- und Furchenfüßer (Caudofoveata und Solenogastres). *Die neue Brehm-Bücherei*, 441: 1-92.

SALVINI-PLAWEN, L. v., 1972a. Zur Morphologie und Phylogenie der Mollusken: Die Beziehungen der Caudofoveata und der Solenogastres als Aculifera, als Mollusca und als Spiralia. *Zeitschrift für wissenschaftliche Zoologie*, 184: 205-394.

SALVINI-PLAWEN, L. v., 1972b. Revision der monegassischen Solenogastres (Mollusca, Aculifera). *Zeitschrift für zoologische Systematik und Evolutionsforschung*, 10: 215-240.

SALVINI-PLAWEN, L. v., 1978. Antarktische und subantarktische Solenogastres (Eine Monographie 1898-1974). *Zoologica (Stuttgart)*, 128: 1-315.

SALVINI-PLAWEN, L. v., 1980. Was ist eine Trochophora? (What is a Trochophora?). *Zoologisches Jahrbuch für Anatomie und Ontogenie der Tiere*, 103: 389-423.

SALVINI-PLAWEN, L. v., 1981a. On the origin and evolution of the Mollusca. *Atti Convegni Lincei*, 49: 235-293.

SALVINI-PLAWEN, L. v., 1981b. The molluscan digestive system in evolution. *Malacologia*, 21: 371-401.

SALVINI-PLAWEN, L. v., 1985. Early evolution and the primitive groups. *The Mollusca* (Academic Press), 10 (Evolution): 59-150.

SALVINI-PLAWEN, L. v., 1988a. The structure and function of molluscan digestive systems. *The Mollusca* (Academic Press), 11 (Form and Function): 301-379.

SALVINI-PLAWEN, L. v., 1988b. Annelida and Mollusca – a Prospectus. *Microfauna marina*, 4: 383-396.

SALVINI-PLAWEN, L. v., 1991. Origin, Phylogeny and classification of the phylum Mollusca. *Iberus*, 9: 1-33.

SALVINI-PLAWEN, L. V. AND BARTOLOMAEUS, T., 1995. Mollusca: Mesenchymata with a <coelom>. *Selected Symposia and Monographs of the U. Z. I.*, 8 (Body cavities: function and phylogeny): 75-92.

SALVINI-PLAWEN, L. v. AND STEINER, G., 1996. Synapomorphies and synplesiomorphies in higher classification of Mollusca. *Origin and evolutionary radiation of the Mollusca* (J. Taylor Edit., Oxford. Univ. Press): 29-51.

SCHELTEMA, A., 1972. The radula of the Chaetodermatidae (Mollusca, Aplacophora). *Zeitschrift für Morphologie der Tiere*, 72: 361-370.

SCHELTEMA, A., 1978. Position of the class Aplacophora in the phylum Mollusca. *Malacologia*, 17: 99-109.

SCHELTEMA, A., 1996: Phylogenetic position of Sipuncula, Mollusca and the progenetic Aplacophora. *Origin and evolutionary radiation of the Mollusca* (J. Taylor edit., Oxford. Univ. Press): 53-58.

SCHELTEMA, A., 1999. New eastern Atlantic neomenioid aplacophoran Molluscs. *Ophelia*, 51: 1-28.

SCHELTEMA, A., 2000. Two new hydrothermal vent species, *Helicoradomenia bisquama* and *Helicoradomenia acredema*, from the eastern Pacific Ocean (Mollusca, Aplacophora). *Argonauta*, 14: 15-25.

SCHELTEMA, A. AND KUZIRIAN, A. M., 1991. *Helicoradomenia juani* gen. et sp. nov., a Pacific hydrothermal vent Aplacophora (Mollusca, Neomenilmorpha). *The Veliger*, 34: 195-203.

SCHELTEMA, A. AND SCHANDER, C., 2000. Discrimination and phylogeny of solenogaster species through the morphology of hard parts (Mollusca, Aplacophora, Neomeniomorpha). *Biological Bulletin*, 198: 121-151.

SCHELTEMA. A., TSCHERKASSKY, M. AND KUZIRIAN, A. M., 1994. Aplacophora. *Microscopic anatomy of Invertebrates*, 5 (Mollusca I): 13-54.

SIMROTH, H., 1893a. Kritische Bemerkungen über die Sysrtematik der Neomeniiden. *Zeitschrift für wissenschaftliche Zoologie*, 56: 310-327.

SIMROTH, H., 1893b. Amphineura (II). *Bronns Klassen und Ordnungen des Tierreichs*, 3 (1). 128-240.

SIRENKO, B. AND MINICHEV, Y., 1975. Developpement ontogénétique de la radula chez les Polyplacophores. *Cahiers de Biologie marine*, 16: 425-433.

SWOFFORD, D. L., 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. 0b10. Sinauer Associates; Sunderland, Massachusetts.

THIELE, J., 1913. Solenogastres. *Das Tierreich*, 38: 1-57.

TODT, C. AND SALVINI-PLAWEN, L. v., 2003. New Simrothiellidae (Solenogastres, Mollusca) from the Moçambique Channel, western Indian Ocean. *The Veliger*, 6: 6-77.

TRUEMAN, E., 1976. Locomotion and the origins of Mollusca. *Perspectives in experimental Biology*, 1 (Zool.): 455-465.

WINGSTRAND, K., 1985. On the anatomy and relationships of recent Monoplacophora. *Galathea Report*, 16: 7-94.

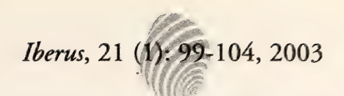
WIRÉN, A., 1892. Studien über Solenogastres I. Kungl. *Svenska Vetenskap Akademiens Handlingar*, 24 (12): 1-66.

WINNEPENNINCKS, B., BACKEJAU, TH. AND DE WACHTER, R., 1996. Investigation of molluscan phylogeny on the basis of 18S rRNA sequences. *Molecular Biology and Evolution*, 13 (10): 1306-1317.

WOLTER, K., 1992. Ultrastructure of the radula apparatus in some species of aplacophoran Molluscs. *Journal of Molluscan Studies*, 58: 245-256.

YU, W., 1984. On Merismoconchids. *Acta palaeontologica sinica*, 23: 432-446.

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The genus *Pelycidion* (Mollusca: Archaegastropoda) in West Africa

El género *Pelycidion* (Mollusca: Archaegastropoda) en Africa occidental

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Recibido el 2-V-2002. Aceptado el 20-XII-2002

ABSTRACT

West African shells of the genus *Pelycidion* (family Pelycidiidae Ponder and Hall, 1983) are studied, photographed and compared; the conclusion reached is that only one variable species is present in this area. Some characteristics of the shell of this species are illustrated.

RESUMEN

Las conchas de Africa Occidental pertenecientes al género *Pelycidion* (familia Pelycidiidae Ponder and Hall, 1983) son estudiadas, fotografiadas y comparadas, llegándose a la conclusión de que, en esta área, sólo existe una especie morfológicamente muy variable. Se muestran y comentan algunos caracteres de la concha.

KEY WORDS: *Pelycidion*, West Africa, shell characters.
PALABRAS CLAVE: *Pelycidion*, África occidental, caracteres de la concha.

INTRODUCTION

FOLIN AND PÉRIER (1873) described from Hong-Kong and Senegal the first known species of the family Pelycidiidae Ponder and Hall, 1983, which was named *Pelycidion venustulum* Fischer.

PONDER AND HALL (1983) proposed the family name Pelycidiidae, with *Pelycidion venustulum* as its type species; the type locality is restricted to Senegal. This work also mentions the generic synonyms and lists the previously known species of this genus, illustrating most of them.

The position of this family in this last work is not clear but it is tentatively placed in Archaegastropoda. Later, BOUCHET AND LE RENARD (1998) placed it near Pickworthiidae; even the possibility that it may be a synonym of this family is mentioned (as a personal communication from W. F. Ponder). OKUTANI (2000) places the family Pelycidionidae (sic!) between the families Pickworthiidae and Cingulopsidae.

Two species from West Africa are mentioned in these works:

-Pelycidion venustulum, represented in PONDER AND HALL (1983, figs. 1F and 1G) showing shells from Mauritania.

-Pelycidion sp., represented in PONDER AND HALL (1983, figs. 1E and 3B-3E) showing shells from Dahomey.

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MATERIAL AND METHODS

In sediment samples dredged by the authors in Ghana, several shells of this genus were found. This material was noted to be complementary with more shells from Senegal (J. Pelorce coll.) and Angola (F. Fernandes coll.). In the present work, the authors have made comparison of the shell characteristics (protoconch, size, sculpture of the last whorl and microsculpture) of all the material obtained, comparing it with those in the above-mentioned literature. All the material studied is in collection of the first author (CER).

Abbreviations:

s shell
f fragment
j juvenile

RESULTS

Genus *Pelycidion* Fischer in Folin and Périer, 1873

Type species: *Pelycidion venustulum* Fischer, 1873. For monotypy.
For synonyms and general characters see PONDER AND HALL (1983).

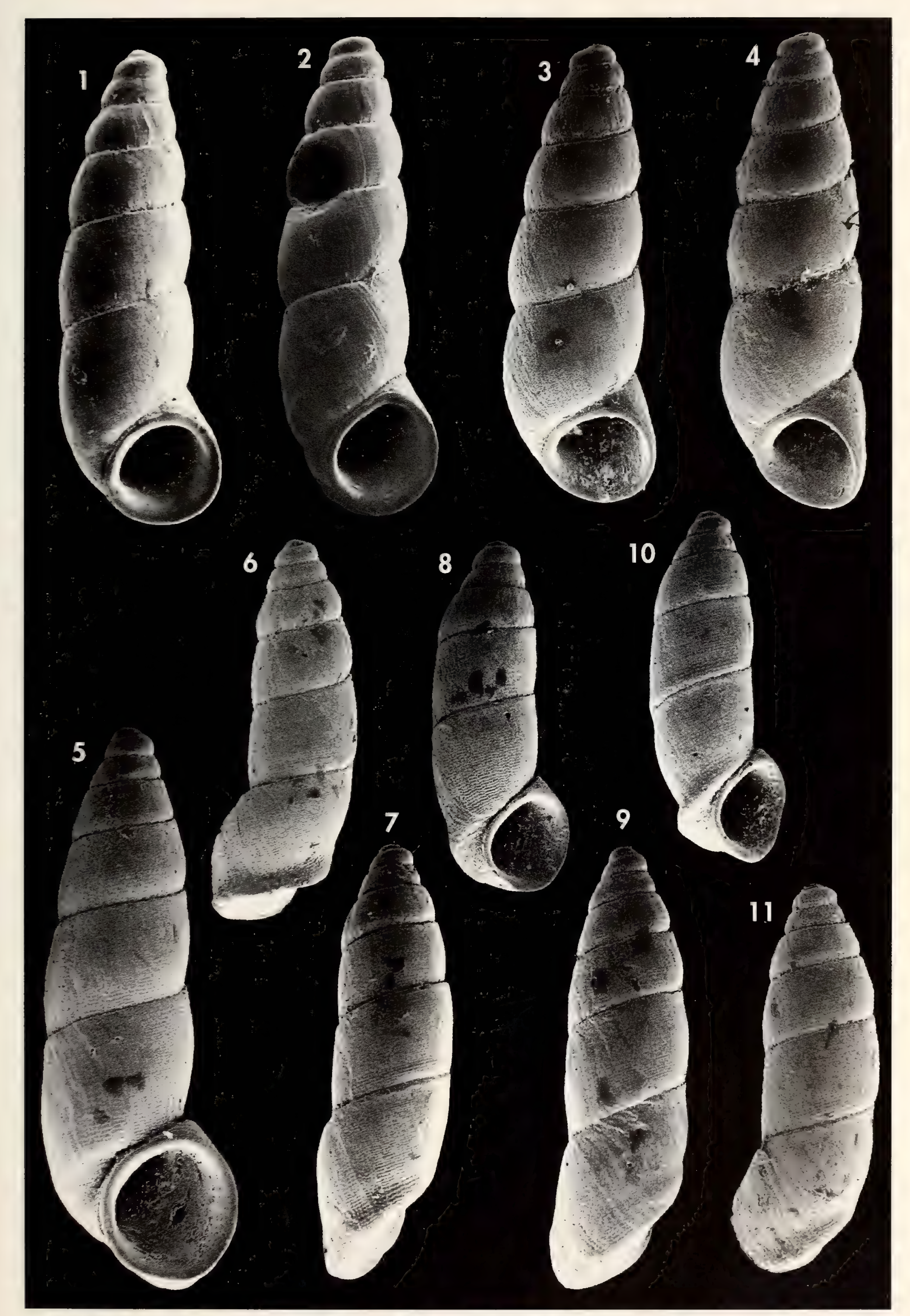
Pelycidion venustulum Fischer, 1873

Pelycidion venustulum Fischer, in Folin and Périer, 1873. *Les fonds de la mer*.: 182.

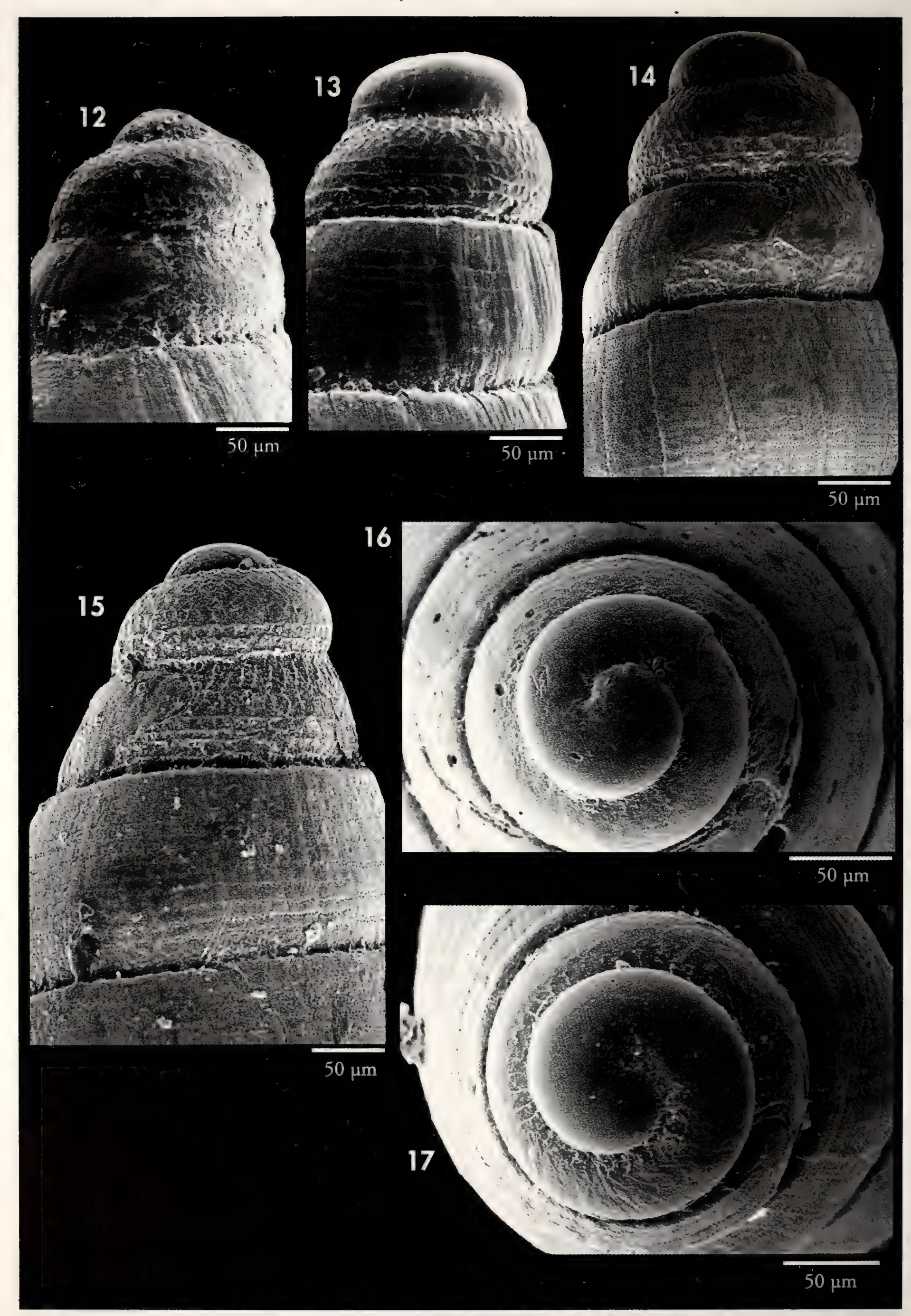
Type material: Untraceable.
Material examined: Senegal: 1 specimen, 2 s, 1 f, Petit Thouriba, Dakar, 35 m ; 2 s, Grand Thiouriba, Dakar, 33 m ; 18 s, Madeleines, Dakar, 6-14 m ; 38 s, Madeleines, Dakar, 18 m ; 23 s, Madeleines, Dakar, 6-14 m ; 15 s, Cap Vert, Epave "Tacoma", 15 m ; 15 s, Tiwa, Dakar, 35 m . Ghana: 3 s, Miamia, 12 m ; 31 s, 6 j, 10 f, Miamia, 35-40 m ; 14 s, Miamia, 45-50 m ; 34 s, 5 f, Cape Three Points, 35-65 m. Angola: 2 s, Corimba, Luanda, 20 m ; 1 s, off Luanda, 60-100 m ; 1 s, Namibe, 25 m .

Description: Shell (Figs. 1-11) minute, elongate-pupoid, relatively solid, whitish or cream-coloured. Protoconch (Figs. 12-17) brownish in fresh shells, with about 2 whorls, with a smooth beginning of almost 1 whorl; the subsequent part exhibits an evident sculpture; in the subsutural area, this is formed at the beginning by an oblique reticulation and at the end by axial ribs; in the middle of the whorl, there are fine spiral threads, being adapically stronger. At the end of the protoconch, there is a pronounced subsutural sinus. The teleoconch has between 3 $^1/_2$– 4 $^1/_2$ whorls which increase in size gradually being hardly convex or almost flat. Suture impressed. The last whorl is large, representing almost $^1/_2$ of the total heigth of the shell. Some shells indicate a last whorl uniformly curved towards the periphery, while others show a strong spiral cord which begins at the end of the suture and forms a peripheral keel. The aperture is circular or subcircular and weakly thickened externally towards the apical part. Peristome simple.

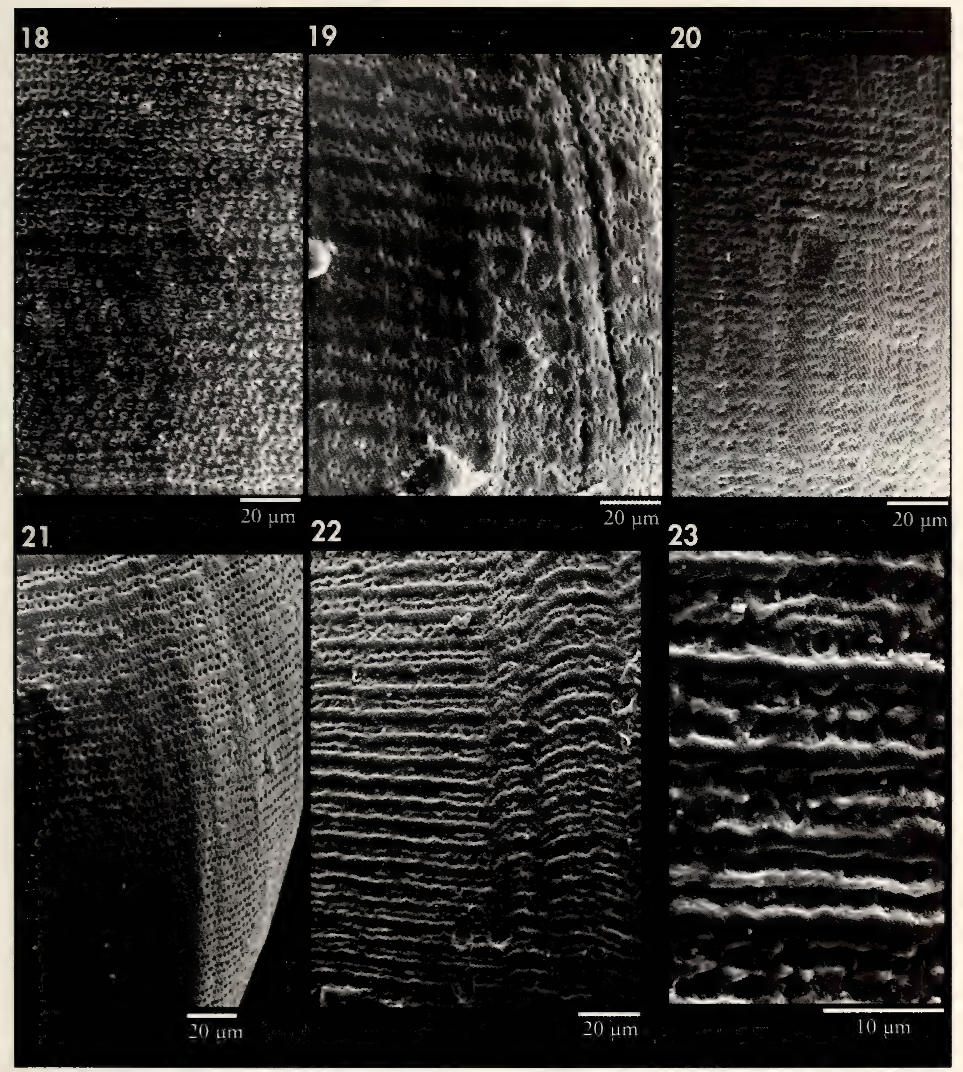
The microsculpture (Figs. 18-23) is hightly variable; sometimes, the shell appears to be smooth and only under magnification the regular spiral striae, which are formed by one or two rows of small indentations separated by larger interspaces, can be observed. In other cases, these rows of pits are separated by similar interspaces and appear as a continuos sculpture. In some shells, stronger striae appear and the pits or indentations may or may not be visible. Even in this last case, one shell we observed exhibits on the first whorls the classical pitted sculpture and on the last whorl this other striated sculpture.



Figures 1-11. Shells of *P. venustulum*. 1: 1.4 mm, Madeleines, Senegal; 2-4: 1.3, 1.3 and 1.3 mm, off Luanda, 60-120 m, Angola; 5-11: 1.8, 1.3, 1.4, 1.1, 1.4, 1.1 and 1.3 mm, Miamia, Ghana.
Figuras 1-11. Conchas de P. venustulum. *1: 1,4 mm, Madeleines, Senegal; 2-4: 1,3, 1,3 y 1,3 mm, fuera de Luanda, 60-120 m, Angola; 5-11: 1,8, 1,3, 1,4, 1,1, 1,4, 1,1 y 1,3 mm, Miamia, Ghana.*



Figures 12-17. Protoconchs of *P. venustulum*. 12: Madeleines, Dakar, Senegal, 35 m; 13: off Luanda, Angola, 60-100 m; 14-16: Miamia, Ghana, 20-65 m; 17: La Tacoma, Dakar, Senegal, 15 m.
Figuras 12-17. Protoconchas de P. venustulum. *12: Madeleines, Dakar, Senegal, 35 m; 13: fuera de Luanda, Angola, 60-100 m; 14-16: Miamia, Ghana, 20-65 m; 17: La Tacoma, Dakar, Senegal, 15 m.*



Figures 18-23. Microsculpture from shells of *P. venustulum*. 18: Senegal; 19, 20: Angola; 21-23. Ghana.

Figuras 18-23. Microesculturа de conchas de P. venustulum. *18: Senegal; 19, 20: Angola; 21-23. Ghana.*

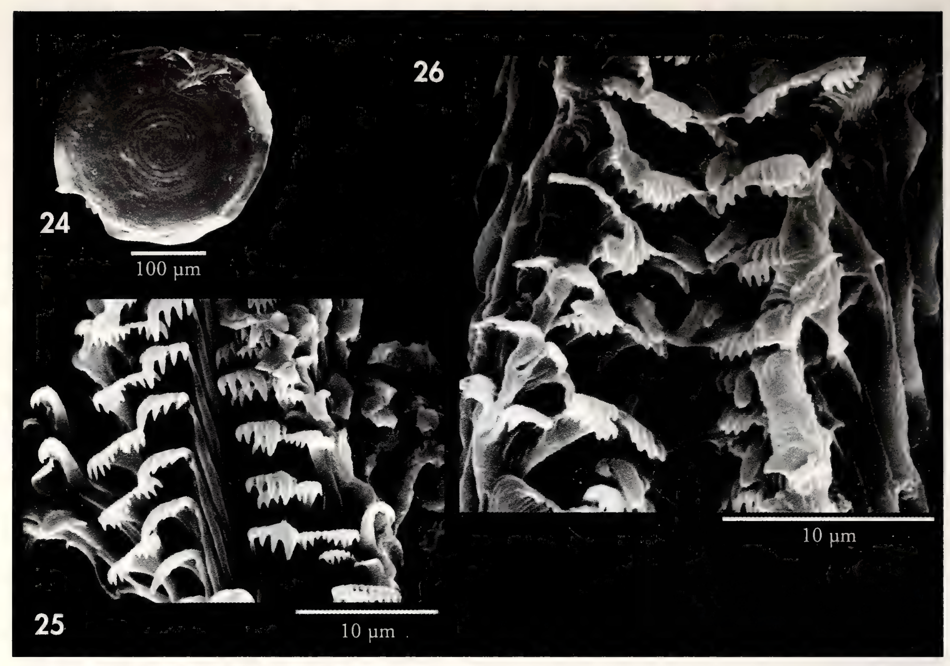
Dimensions: The shell heigth is variable, the smallest shells of our material measured 1.0 mm, and the largest 1.8 mm; material of both sizes was collected in the same place.

Operculum (Fig. 24) is multispiral; it was examined in only one specimen of *Pelycidion* from Dakar, with the operculum visible at the aperture and the soft parts dry into.

Radula (Figs. 25, 26) which has the same appearance to that showed in PONDER AND HALL (1083) from a species of West America.

Distribution: The species is known from Mauritania (mentioned in PONDER AND HALL, 1983) and Senegal (type locality) up to Angola.

Discussion: After the examination of the material from several countries and



Figures 24-26. *P. venustulum*, Dakar, Senegal. 24: Operculum; 25, 26: radula.
Figuras 24-26. P. venustulum, *Dakar, Senegal. 24: Opérculo; 25, 26: rádula.*

the graphic material shown in PONDER AND HALL (1983) we have found that the morphology of this sepcies is very variable and there are intergradation between the different sized shells as well as in the sculpture of the last whorl and microsculpture. For these reasons we conclude that only one species exists on the West African coast which we illustrate in this work from several aspects to show the variability.

ACKNOWLEDGEMENTS

Our thanks to J. Pelorce for the loan of material; to Jesús Méndez of the CACTI of the University of Vigo for the SEM photographs; also to the PARSYST project for our estance in the MNHN of Paris, and the bibliographic information.

This work has been partially supported by a grant of XUNTA DE GALICIA PGIDTOOPXI30121PR.

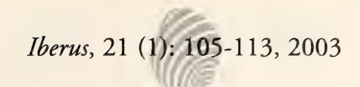
BIBLIOGRAPHY

BOUCHET, P. AND LE RENARD, J. 1998. Family Pickworthiidae, pp. 739-741. In Beesley, P. L., Ross, G. J. B. and Wells, A. (Eds.). Mollusca: *The Southern Systhesis. Fauna of Australia*, vol 5. CSIRO Publishing, Melbourne, Part B., 565-1234.

FOLIN, L. DE AND PÉRIER, L. 1867-1886. *Les fonds de la mer, étude internationale sur les particularités nouvelles des régions sous-marins*. 4 vol. Paris.

OKUTANI, T. (ed.). 2000. *Marine mollusks in Japan*. Tokai University Press, Tokyo. 1173 pp.

PONDER, W. F. AND HALL, S. J. 1983. Pelycidiidae, a new family of Archaegastropod molluscs. *The Nautilus*, 97 (1): 30-35.



El conducto excretor de la glándula de la cápsula de *Bolinus brandaris* (Gastropoda Prosobranchia): estudio estructural y ultraestructural

Structural and ultrastructural study of the excretor duct of the capsule gland of *Bolinus brandaris* (Gastropoda, Prosobranchia)

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Recibido el 4-X-2002. Aceptado el 11-I-2003

RESUMEN

El conducto excretor de la glándula de la cápsula de *Bolinus brandaris* recorre la glándula en toda su longitud y está tapizado por un epitelio prismático ciliado y con microvilli que lo separa de los agregados glandulares adyacentes. Núcleo en posición basal, la heterocromatina se distribuye dispersa en el nucleoplasma, y en una banda periférica. El citoplasma presenta abundante glucógeno y gran cantidad de formaciones vesículo-membranosas; hay un gran desarrollo del complejo de Golgi y lisosomas, así como formaciones semejantes a figuras mielínicas, de naturaleza glucídica. El retículo endoplasmático está escasamente desarrollado. La presencia de cilios, microvilli e invaginaciones de la membrana basal corresponde a células con función de reabsorción, transporte y difusión de compuestos, las vesículas de secreción suponen además una función secretora. Se supone que estas células sintetizarían materias primas procedentes de las células glandulares vecinas. Esta hipótesis se basa no sólo en el gran desarrollo de los sistemas endomembranosos, sino también en la presencia de vesículas similares a las presentes en las células glandulares vecinas.

ABSTRACT

The excretory duct of the capsule gland of *Bolinus brandaris* runs along the gland and is covered by a columnar epithelium with microvilli and cilia which separates it from the adjacent gland complexes. Nucleus located in the base of the cell. Scattered drops of heterochromatin could be seen in the nucleoplasm. An heterochromatin band was also found around the periphery. The cytoplasm was homogeneously full of glycogen. Vesicle-membranous formations were well developed (especially, a Golgi body). Associated to the latter were abundant vesicles, lysosomes, and glucidic myelin-like bodies. The endoplasmic reticulum was not well developed. The presence of cilia, microvilli and basal membrane invaginations is typical of cells dedicated to transport, resorption and difussion; the highly-developed membranes also suggest a secretion role. It is possible that material previously synthesized in neighbouring gland cells could be transported for further elaboration in these cells. The presence of vesicles similar to those found in neighbouring gland cells and the well- developed endomembranous structures support this hypothesis.

PALABRAS CLAVE: Aparato reproductor femenino, conducto excretor, glándula de la cápsula, epitelio vibrátil, endomembranas.
KEY WORDS: Female reproductive system, excretory duct, capsule gland, vibratile epithelium, endomembranes.

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INTRODUCCIÓN

El aparato reproductor de los moluscos presenta diversos grados de complejidad en base al tipo de fecundación: si es externa el sistema reproductor es muy sencillo, si es interna es altamente complejo (JONG-BRINK, BOER Y JOOSSE, 1983). En los moluscos con fecundación interna se describen tres tipos de glándulas accesorias: la glándula de la albúmina, responsable de la formación de las cubiertas oocitarias; glándula ingestiva (receptáculo seminal), donde tiene lugar la fecundación y posterior degradación de los espermatozoides sobrantes o defectuosos y la glándula de la cápsula, donde los huevos fecundados son empaquetados definitivamente para la puesta. Estas tres glándulas están comunicadas entre sí y surcadas por un conducto (oviducto) que, partiendo del ovario las atraviesa. El conducto excretor de la glándula de la cápsula es por tanto una doble vía: de entrada de los espermatozoides, y de salida de los huevos (FETTER, 1941; HYMAN, 1967; GRASSÉ, 1968; OEHLMANN, STROBEN Y FIORONI, 1988; SCHULTE-OEHLMANN, FIORONI, OELMANN Y STROBEN, 1994 y OEHLMANN, FIORONI, STROBEN Y MARKERT, 1996).

Al ser interna la fecundación de *Bolinus brandaris*, estos tres tipos glandulares se hallan presentes en su aparato reproductor femenino. Los aspectos estructurales y ultraestructurales del conducto excretor de la glándula de la cápsula, son objeto del presente trabajo.

MATERIALES Y MÉTODOS

Glándulas de la cápsula de hembras de *Bolinus brandaris*, procedentes de diversos puntos de la costa catalana, (principalmente Sant Carles de la Ràpita, Tarragona), fueron extraídas y procesadas para su estudio en microscopía óptica y electrónica.

Para el estudio en microscopía óptica, glándulas enteras fueron fijadas en formol 10%, e incluidas en parafina. Cortes de 6 µm de grosor, fueron teñidos con las técnicas de.: hematoxilina-eosina, Mallory, y la técnica histoquímica del ácido periódico de Schiff (PAS) específica para la detección de carbohidratos.

Para la observación en microscopía electrónica, pequeñas secciones de glándulas(1mm de grosor), fueron procesadas con la técnica convencional de la doble fijación glutaraldehído 2,5%-paraformaldehído 3,5% y tetróxido de osmio al 2%, tamponados con tampón fosfato (Sörensen). Tras una deshidratación progresiva, fueron incluidas en resina Spurr. Cortes semifinos (1 µm de grosor) a fin de seleccionar el área donde realizar los cortes ultrafinos (30 nm) se tiñeron con azul de metileno-bórax. Los cortes ultrafinos fueron realizados con un ultramicrótomo Reichert-Omu provisto de cuchilla de diamante. Tras ser recogidos con rejillas de cobre, se procedió al doble contrastado con acetato de uranilo y citrato de plomo. En los casos que se realizó la técnica citoquímica de Thièry, detectora de carbohidratos, las muestras fueron recogidas con rejillas de oro y no contrastadas posteriormente. Las observaciones se realizaron con los microscopios electrónicos Philips 301 y Hitachi 600, de los Servicios Científico-Técnicos de la Universidad de Barcelona.

RESULTADOS Y DISCUSIÓN

La glándula de la cápsula de *Bolinus brandaris*, tal como está descrito en otras especies (HYMAN, 1967; GRASSÉ, 1968 Y OEHLMANN *ET AL.*,1988) es la mayor de las glándulas del tracto genital femenino. Macroscópicamente, la glándula de la cápsula de *Bolinus brandaris* presenta morfología redondeada, alargándose ligeramente en sus extremos. Exteriormente es de color blanco–ocre, y está dividida en dos lóbulos, derecho e izquierdo, semejante a las descripciones de FETTER (1941) y OEHLMANN *ET AL.*, 1996. Muy desarrollada en la época de madurez sexual (primavera principalmente), en épocas de reposo (resto del año), está prácticamente atrofiada.

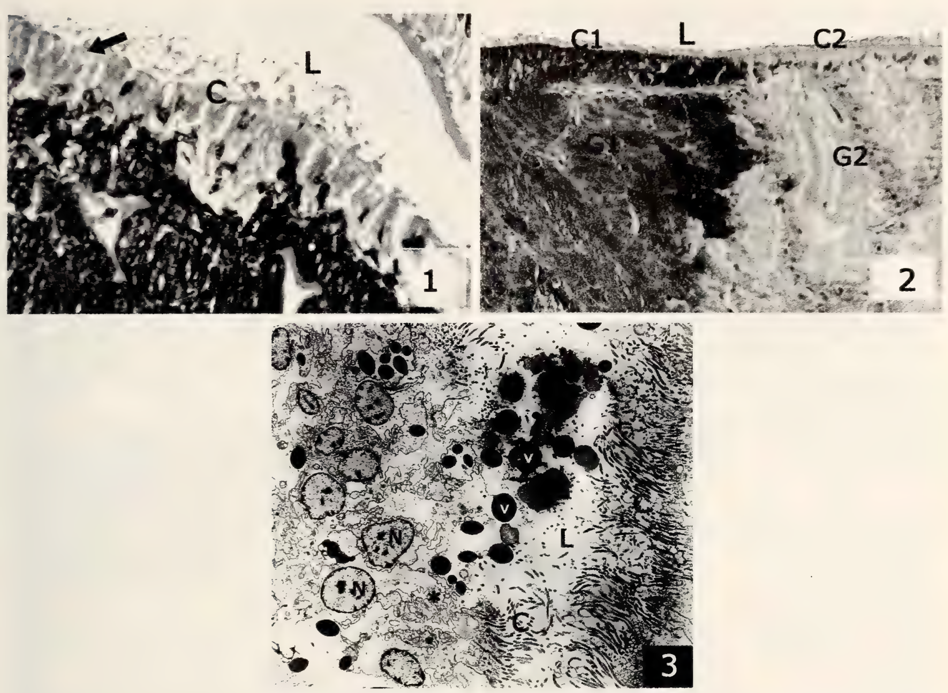
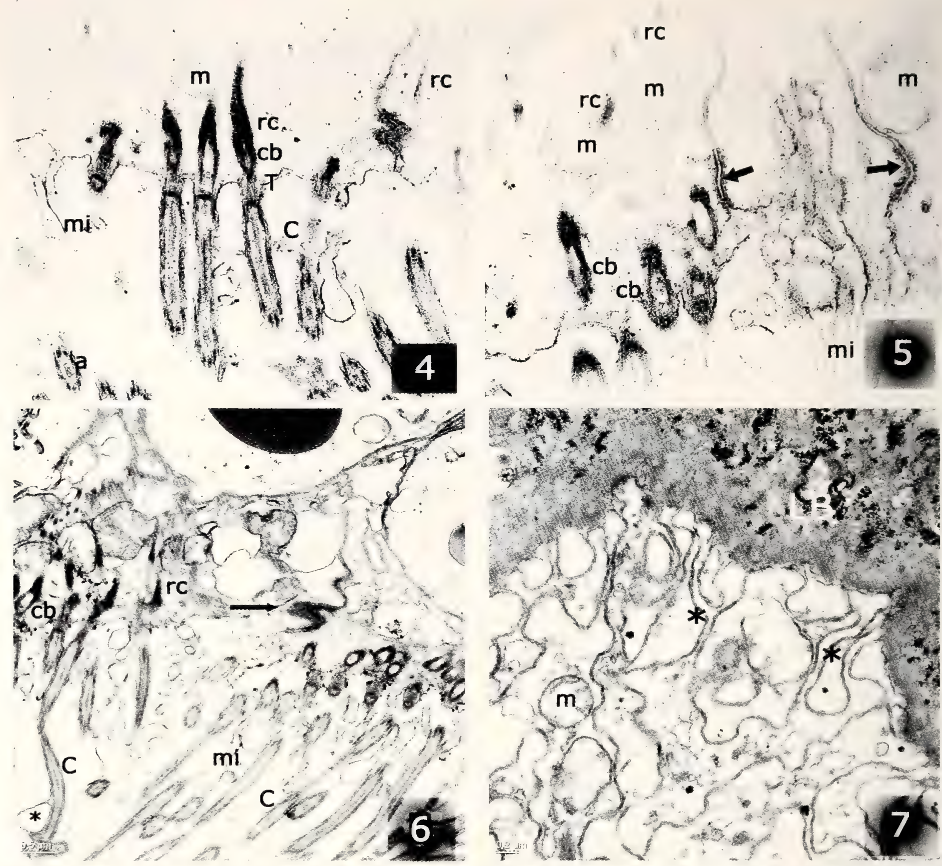


Figura 1. Detección de la glándula de la cápsula a nivel de la luz (L) del conducto excretor. Puede observarse cómo las células del epitelio ciliado (C) son invadidas por material basófilo (Flecha) similar al contenido en las glándulas adyacentes. Hematoxilina- eosina. Figura 2. Zona colindante entre dos áreas glandulares diferentes (G1 y G2): Mientras G1 es altamente eosinófila, G2 presenta una clara basofilia. Obsérvese como los epitelios ciliados correspondientes a estas áreas (C1 y C2), presentan afinidades tintoriales diferentes entre sí, y similares a la de sus glándulas adyacentes. Hematoxilina-eosina. Figura 3. Panorámica ultraestructural del epitelio ciliado del conducto excretor donde se aprecian los núcleos (N), los cilios (C) así como múltiples formaciones membranosas (asterisco) . En la luz del conducto (L) pueden apreciarse vesículas de diverso tamaño y electrodensidad (v).

Figure 1. The excretory duct of the capsule gland showing its lumen (L). Ciliate cells (C) are invaded by basophilic material (arrow). See its similarity of this material with that inside of the neighbouring cells. Hematoxilin-eosin. Figure 2. Detail of two different areas of glandular masses. While G1 has eosinophil pH, G2 has intense basophilia. The ciliate epithelia next to these areas (C1 and C2) have varying staining properties. However, these properties are similar to those of their neighbouring glands. Hematoxilin-eosin. Figure 3. Ultrastructural observation of the ciliated epithelium of the excretor duct. Observe nuclei (N), cilia (C) as well as several membranous formations (asterisk). Vesicles (v) of different size and electrondensity appear in the lumen (L).

A microscopía óptica, y tal como se observa en varias especies (HYMANN, 1967; GRASSÉ, 1968; SHULTE-OEHLMANN *ET AL.*, 1994; FETTER Y GRAHAM, 1994; OEHLMANN *ET AL.*, 1996) se observa que ambos lóbulos están formados por masas glandulares de diferente naturaleza, que se ponen en evidencia por su diferente afinidad tintorial, cuyo contenido es excretado a un conducto irregular que surca a la glándula en toda su longitud (Figs. 1, 2). Este conducto excretor está tapizado por un epitelio prismático ciliado (75 µm de altura) y con microvilli como se observa con el microscopio electrónico (Figs. 3-5). La afinidad tintorial de estas células es similar a la de las células glandulares vecinas.

La imagen ultraestructural de este epitelio corresponde a la descrita en la



Figuras 4-6. Zona apical del epitelio ciliado. Obsérvense los cilios (C) mostrando sus partes características: el axonema en secciones transversales (a), la zona de transición (necklace) (T), el corpúsculo basal (cb) y las raíces ciliares próximas a mitocondrias (m). Asimismo pueden detectarse microvilli (mi) y desmosomas (flecha). Véase la presencia de un cilio en forma de "discocilio" en la Figura 6 (asterisco). Figura 7. Detalle de la parte basal celular. Puede observarse la lámina basal (LB) y las múltiples invaginaciones de la membrana plasmática basal (asterisco).

Figures 4-6. View of the apical area of ciliate epithelia. The typical structure of cilia (C) is apparent, i.e. transversal sections of the axoneme (a), the transition zone (necklace) (T), the basal body (cb) and the rootlets besides mitochondria (m). Microvilli (mi) and desmosomes (arrow) are also apparent. Modified cilia, i.e. disk-cilia, can be seen in Figure 6 (asterisk). Figure 7. View of a basal cell. The basal lamina (LB) and the multiple invaginations of the basal membrane are visible (asterisk).

mayoría de oviductos, tanto de invertebrados como de vertebrados (FETTER, 1941; SHULTE-OEHLMANN *ET AL.*, 1994; OEHLMANN *ET AL.*, 1996; PALMER Y GUILETTE, 1988 y HAGIWARA,1995) mostrando células ciliadas, con núcleo basal, y gránulos de electrodensidad variable en su citoplasma que también se detectan en la luz del conducto (Fig. 3). A mayores aumentos, se observa, como se ha citado anteriormente, la presencia de cilios y microvilli en su cara apical (Figs. 4 y 5). Estos cilios tienen un corpúsculo basal de 0,2 μm, que se prolonga con la característica raíz ciliar de aspecto estriado (DENTLER, 1981; DUSTIN, 1984; DENTLER, 1990; AMOR, 1992 , 1996 ; HAGIWARA, 1995) de 0,8 μm de longitud y con una periodicidad de 8 nm. En

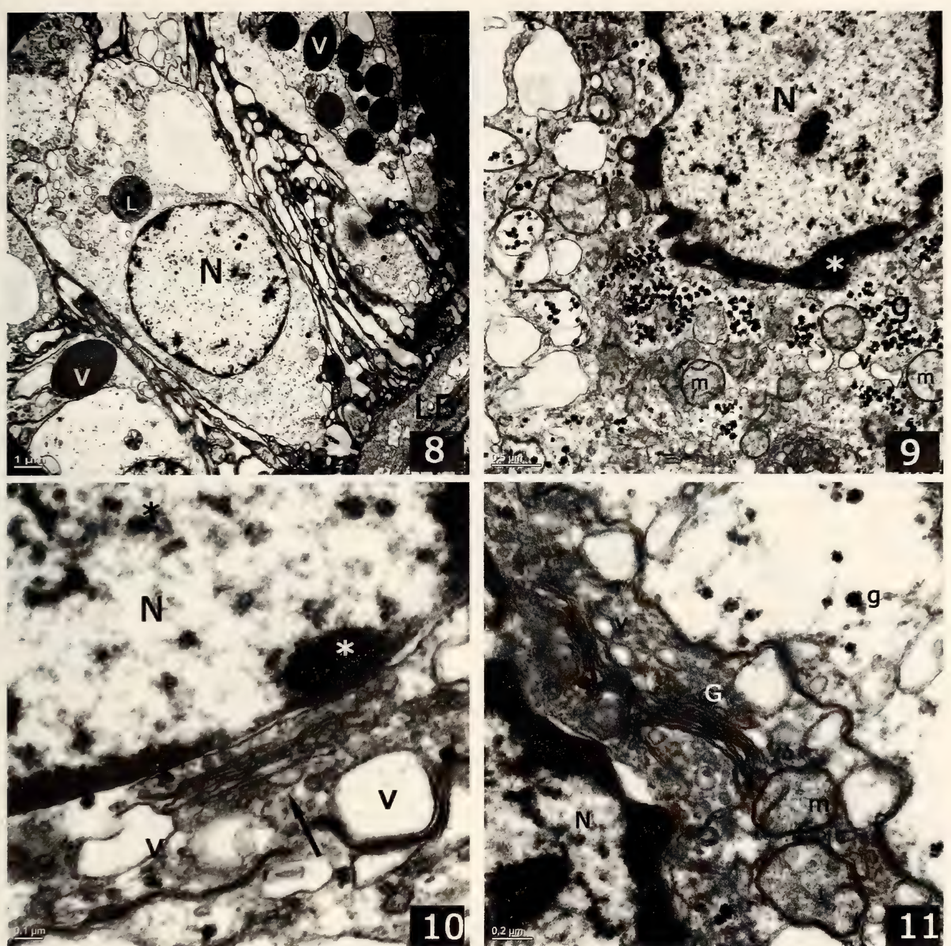


Figura 8. Sección longitudinal de la zona basal de una célula prismática. Se observa el núcleo (N) la lámina basal (LB), múltiples repliegues de la membrana plasmática (asterisco) así como lisosomas (L) y diversos orgánulos vesículo-membranosos (v) dispersos por el citoplasma. Figura 9. Sección del núcleo rodeado de mitocondrias (m), gránulos de glucógeno (g) y vesículas de diferentes tamaños (v). Figuras 10, 11. Imágenes de las diversas morfologías adoptadas por el complejo de Golgi (G) en sus proximidades al núcleo (N). Obsérvese asimismo la presencia se glucógeno (g), mitocondrias (m) y vesículas de diferentes tamaños (v).

Figure 8. Longitudinal section of the basal area of a prismatic cell. See the nucleus (N) and the basal lamina (LB) as well as invaginations in the basal plasma membrane (asterisk), lysosomes (L) and vesicle membranous organelles (v) spread through the cytoplasm. Figure 9. Ultrastructure view of the nucleus surrounded by mitochondria (m), glycogen granules (g) and different- size vesicles. Figures 10, 11. Diverse shapes adopted by the Golgi body (G) near the nucleus (N). Glycogen granules (g), mitochondria (m) and different size vesicles (v) are also be seen.

sentido ascendente se observa el característico *necklace* o zona de transición (AMOR, 1996) que acaba en el cilio característico. En un 3% de cilios, aparecen dilataciones en la parte apical del mismo configurando el tipo discocilia semejantes al gonoducto masculino de esta especie. (AMOR, 1992, 1996). Aunque ha sido discutida la real existencia de este tipo de cilios con anormalidades morfológicas, actualmente está

ampliamente aceptada su existencia, significando una facilitación en la circulación de material denso (Durfort, Bozzo, Poquet, Sagristà, Ferrer, García Valero, Amor y Ribes, 1990; Cajaraville, Marigómez y Angulo, 1990, Amor, 1992, 1996; Hagiwara, Ohwada, Akoi and Tanaka, 2000; Ludin y Schauder, 2001). En el caso presente, sería lógica su presencia ya que por este conducto han de circular tanto las secreciones segregadas como los oocitos en todas sus fases. Es frecuente la presencia de mitocondrias junto a estas raíces ciliares que, como ha sido ya descrito, supone aporte energético (Durfort, Amor, Ferrer, García Valero, Poquet, Ribes y Sagristá, 1988; Durfort, Bozzo, Poquet, Sagristà, Ferrer, García Valero, Amor y Ribes, 1990 y Amor, 1992) (Figs. 4, 5). La longitud de los cilios varía según el tramo del conducto del que se trate. En el inicio del conducto, es decir la parte próximal al ovario, los cilios son más cortos (12,5 µm) que en la parte distal del mismo (20 µm), lo que podría facilitar la evacuación de los huevos encapsulados.

La zona lateral de la membrana plasmática, en su parte más cercana a la luz, presenta las características uniones celulares, se trata de largos desmosomas en banda, de hasta casi 3 µm de longitud con la característica morfología de anillo rodeando dos membranas contiguas (Cliffe, 2002) (Figs. 4, 5). No se encuentran sin embargo adyacentes a uniones septadas como se describe en otros invertebrados (Duvert, Gros y Salat, 1980; Amor, 1992; Knox y Brown, 2000)

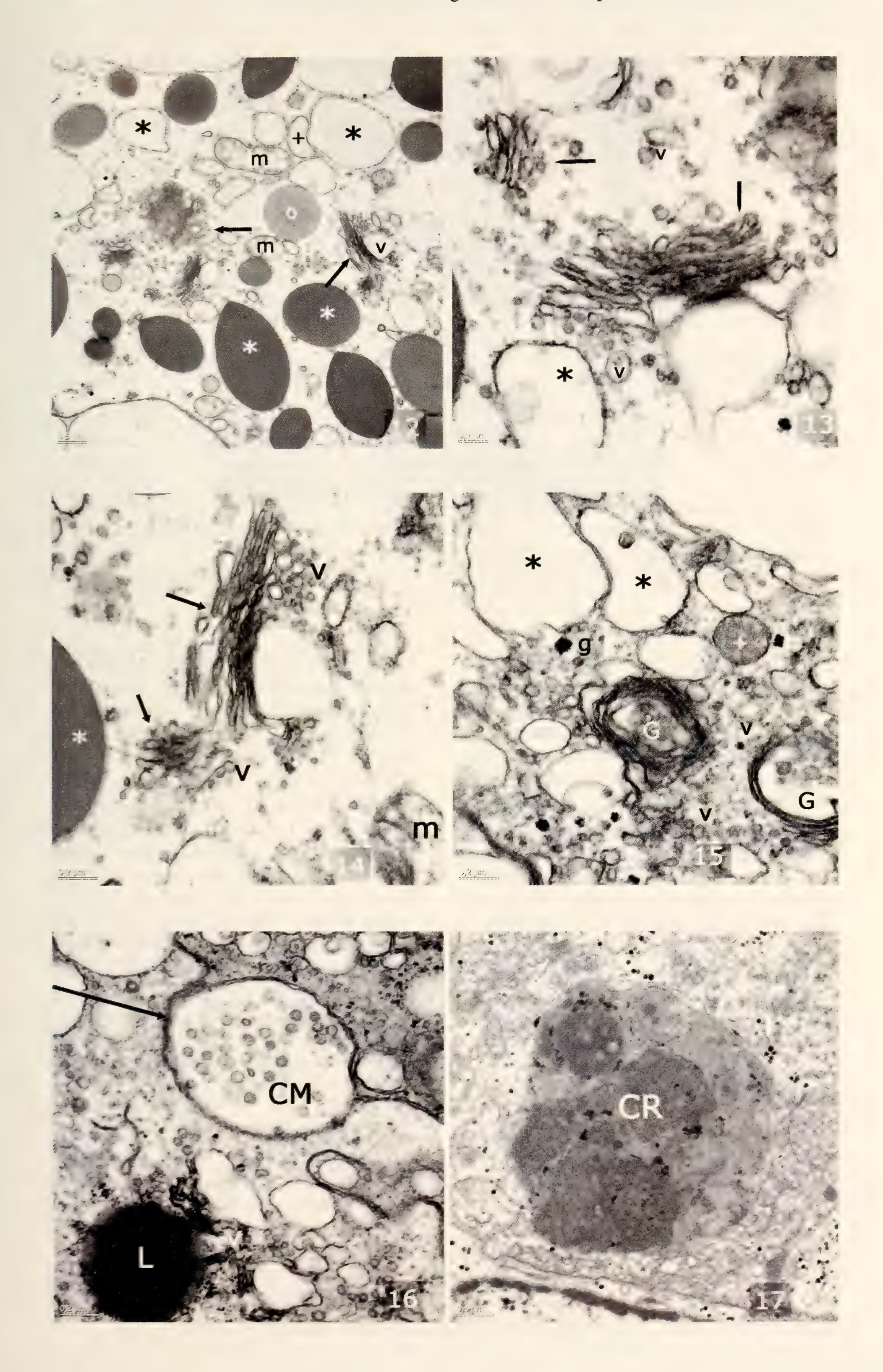
La zona basal de la membrana plasmática, se apoya en la lámina basal, y presenta múltiples invaginaciones que invaden gran parte del citoplasma (Fig. 7). Esta morfología de invaginaciones basales asociada a microvilli corresponde a un patrón celular de un epitelio de absorción y difusión de productos, citado por Amor (1992) en el gonoducto masculino de esta especie.

El núcleo se encuentra en la zona basal de la célula. Presenta morfología oval-redondeada (6,2 µm) con un patrón de heterocromatina dispuesto en grumos dispersos por el nucleoplasma y una banda de heterocromatina periférica (Figs. 3, 8-11). Formaciones de tipo golgiano son frecuentes en sus proximidades (Figs. 10, 11).

El resto del citoplasma se halla invadido por gránulos de glucógeno, distribuido de forma homogénea en el interior celular, mitocondrias, algunas de las cua-

(Página derecha) Figuras 12-15. Diversas morfologías del comportamiento del complejo de Golgi. Figura 12. Dictiosomas (flechas) rodeados de pequeñas vesículas de secreción (v), y otras de mayor tamaño, que por su morfología podrían corresponder a mitocondrias degeneradas (asterisco). Figuras 13, 14. Dictiosomas (flechas) con gran actividad secretora (v). En la Figura 13 se observa la presencia de vesículas similares a mitocondrias degeneradas (asterisco) y en la Figura 14, puede observarse parcialmente una vesícula de alta electrodensidad (asterisco). Figura 15. Dos dictiosomas concéntricos (G) rodeados de pequeñas vesículas (v), otras medianas cargadas de material electrodenso (+) y unas mayores (asterisco) de posible origen mitocondrial. Se observan asimismo gránulos de glucógeno (g). Figura 16. En esta imagen se aprecia la presencia de un cuerpo multivesicular (CM) y un lisosoma (L), rodeados de vesículas (v) de variado tamaño. Figura 17. Cuerpo residual (CR) muy frecuente en este tipo de células.

(Right page) Figures 12-15. Detail of different shapes of the Golgi body. Figure 12. Dyctiosomes (arrows) surrounded by little secretion vesicles (v). Larger vesicles are also detected (asterisk). Their morphology suggests they are degenerate mitochondria. Figures 13, 14. Dyctiosomes (arrows) with intense secretory activity (v). Note the vesicle-like degenerate mitochondria (asterisk) in Figure 13. A high electrondensity vesicle is partially visible in Figure 14 (asterisk). Figure 15. Concentric dyctiosomes (G) surrounded by little vesicles (v). Also median vesicles containing electrondense material (+), large vesicles possibly derived from degenerate mitochondria (asterisk) and glycogen granules are shown. Figure 16. Multivesicular body (CM) and lysosome (L) surrounded by different-size vesicles (v). Figure 17. Residual body. Typical of this kind of cells.


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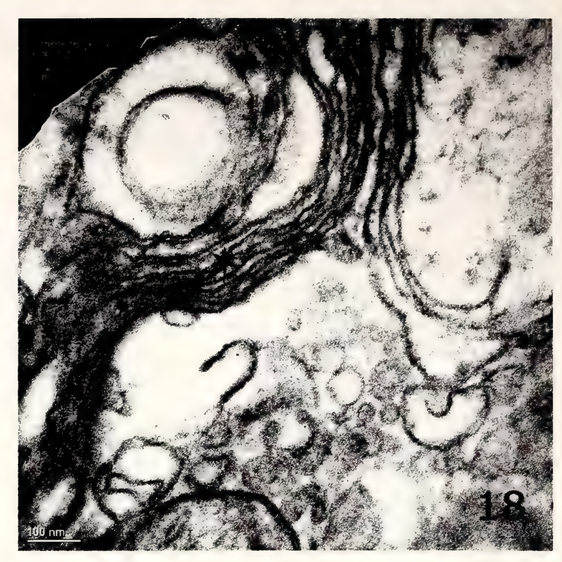


Figura 18. Formaciones membranosas similares a figuras mielínicas, tratadas con la técnica de Thièry (asterisco), lo que confirma su naturaleza membranosa y no artefactual.
Figure 18. Thiery's technique corroborates that myeline-like figures (asterisk) are membranes, not artifacts.

les parecen presentar pérdida progresiva de crestas (Figs. 12, 15). El sistema membranoso más desarrollado es el complejo de Golgi (Figs. 12-15). Este está formado por múltiples dictiosomas de morfología muy variada, que se rodean de múltiples formaciones vesículo-membranosas. Es frecuente encontrar cuerpos multivesiculares y lisosomas en diversas fases de formación (Figs. 16, 17), así como formaciones membranosas Thièry positivas, que recuerdan figuras mielínicas (Fig. 18). El hecho de ser Thiery positivas confirma su naturaleza glucídica descartando que se trate de artefactos, hecho que se da también en ciertas fases de la formación de las plaquetas vitelinas (AMOR, RAMÓN Y DURFORT, 2001). Algunas de estas vesículas presentan material de variable electrodensidad (Figs. 12, 14), que pueden visualizarse también tanto en las células glandulares vecinas como en la luz del conducto. Se observa además la presencia de gránulos muy semejantes tanto por su afinidad tintorial como por las reacciones histo-citoquímicas a los gránulos presentes tanto en la luz del conducto como en las células glandulares vecinas. Este hecho podría sugerir una actividad elaboradora por parte de estas células, donde las materias primas (productos glandulares sintetizados en las glándulas vecinas) serían transferidos a estas células que, mediante el complejo de Golgi los convertiría en gránulos de secreción. Estos gránulos, serían incorporados a vesículas de origen golgiano y mitocondrias degeneradas, a manera de las plaquetas vitelinas en los oocitos (AMOR *ET AL.*, 2001). El hecho del gran desfase entre el alto desarrollo del complejo de Golgi y el escaso desarrollo del retículo endoplasmático parece apoyar esta hipótesis.

A diferencia de otros Gasterópodos (VERMEIRE Y HINCH, 1984), en este conducto no se detectan células caliciformes.

AGRADECIMIENTOS

A David Balayla por su asesoramiento en la lengua inglesa y a Enric València por su ayuda en el procesado digital de las fotografías.

Este proyecto está financiado por el Centre de Referència d'Aquicultura de la Generalitat de Catalunya.

BIBLIOGRAFÍA

AMOR, M. J., 1992. Ultrastructural study of the mucosa of the male gonoduct of *Murex brandaris (Hexaplex brandaris)* (Gastropoda, Prosobranchia). *Invertebrate Reproduction and Development*, 21 (2): 149-160.

AMOR, M. J., 1996. Presence of abnormal cilia in the mucosa of the male gonoduct of *Bolinus (Murex) brandaris* (Gastropoda, Prosobranchia, Muricidae). *Iberus*, 14 (2): 169-178.

AMOR, M. J., RAMÓN, M. Y DURFORT, M., 2001. Vitellin platelets formation on oogenesis of *Bolinus (Murex) brandaris. Mycroscopy 2001.* Barcelona. Abstracts,: 234.

CAJARAVILLE, M. P, MARIGÓMEZ, J. A. AND ANGULO, E., 1990-1991. Light and electron microscope study of the gills epithelium of *Littorina littorea* (Gastropoda, Prosobranchia. *Biological Structure and Morphology*, 3 (1): 1-12.

CLIFF, A., 2002. Localizing adherens junctions. *Trends in Cell Biology*, 12 (6): 252.

DENTLER, W., 1981. Microtubule-membrane interactions in cilia and flagella. *Interational Review of Cytology*, 72: 1-47.

DENTLER, W., 1990. Linkages between microtubules and membranes in cilia and flagella. *"Ciliar and flagellar membranes"*. Robert A. Bloodgood. Plenum Press. London,: 31-64.

DURFORT, M., AMOR, M. J., FERRER, J., GARCÍA VALERO, J., POQUET, M.., RIBES, E Y SAGRISTÁ, E., 1988. Caracterización ultrastructural del epitelio branquial de *Tapes decussatus* L. (Mollusca, Bivalvia). *Iberus*, 8 (2): 141-152.

DURFORT, M.., BOZZO, M. G., POQUET, M., SAGRISTÀ, E., FERRER, J., GARCÍA VALERO, J., AMOR, M. J. Y RIBES, E., 1990. Ultraestructura del epitelio vibrátil de los gonoductos de *Tapes decussatus* y *Tapes semidecussatus. Actas del III Congreso Nacional de Acuicultura,*: 587-592.

DUSTIN, P., 1984. *Microtubules"* 2ª ed. Springer-Verlag. Berlin. 482 pp.

DUVERT, M., GROS, D. AND SALAT, C., 1980. The junctional complex in the intestine of *Sagitta setosa* (Chaetognatha): the paired septate junction. *Journal of Cell Sciences*, 42: 227-246.

DUVERT, M., AND GROS, D., 1982. Further studies on the junctional complex in the intestine of *Sagitta setosa*. Freeze fracture on the pleated septate junction. *Cell and Tissue Research*, 225 (3): 663-671.

FRETTER, V., 1941. The genital ducts of some British Stenoglossan Prosobranchs. *Journal of Marine Biological Association, United Kingdom*, 25: 173-211.

FETTER, V. AND GRAHAM, A., 1994. *British Prosobranch Molluscs*. The Ray Society, London, 765 pp.

GRASSÉ, PP., 1968. *Traité de Zoologie. T. V. Fasc. 3.* Masson et Cie. París. 919 pp.

HAGIWARA, H., 1995. Electron microscopic studies of ciliogenesis and ciliary abnormalities in human oviduct epithelium. *Italian Journal of Anatomy and Embryology, 100 Supplement* 1: 451-459.

HAGIWARA, H., OHWADA, N., AKOI, T AND TANAKA, K., 2000. Ciliogenesis and ciliary abnormalities. *Medical Electron Microscopy*, 33 (3): 109-114.

HYMAN, L. H., 1967. *"The Invertebrate"*. Vol. VI, Mollusca I. McGraew-Hillad. New York. 550 pp.

JONG-BRINK, M. DE, BOER, H. H. AND JOOSSE, J., 1983. *Reproductive Biology of Invertebrates. Mollusca.* Vol. I Oogenesis, Oviposition and Oosorption. K. G. Adiyodi y R. G. Adiyodi. John Wiley & Sons. New York. 770 pp.

KNOX, A. L. AND BROWN, N. H., 2002. Rap1GTPase regulation of adherens junction positioning and cell adhesion. *Science*, 295: 1285-1287.

KORKANOVA, E. E. AND MARCHENKOV, A. V., 2000. Structure of the epithelium of the parasitic turbellaria *Notenera ivanovi* (Turbellaria: Fecampiida). *Parazitologiia*, 34 (6): 515-521.

OEHLMANN, J., STROBEN, E. UND FIORONI, P., 1988. Zur anatomie und histologie des fortpflanzungssystems von *Nucella lapillus* (L. 1758) (Prosobranchia, Stenoglosa). *Zoolgischer Anzeiger*, 221: 101-116.

OEHLMANN, J., FIORONI, P., STROBEN, E. AND MARKERT, B., 1996. Tributylin (TBT) effects on *Ocinebrina aciculata* (Gastropoda, Muricidae): imposex development, sterilisation, sex change and population decline. *Science of the Total Environment*, 188: 205-223.

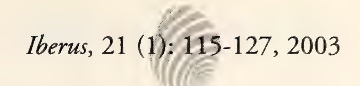
PALMER, B. D. AND GUILLETTE, L. J. Jr., 1988. Histology and morphology of the female reproductive tract of the tortoise *Gopherus polyphemus. American Journal of Anatomy, 183 (3): 200-211.*

SCHULTE-OEHLMANN, U., FIORONI, P., OELMANN, J. AND STROBEN, E., 1994. The genital system *Marisa cornuaretis* (Gastropoda, Ampullariidae) -a morphological and histological analysis. *Zoolgische Beitträge N. F.* 36 (1): 59-81.

THIÈRY, J. P., 1967. *"Staining methods for sectioned materia"*. Ref. Lewis Knight. North Holland 1977.

VERMEIRE, P. E. AND HINCH, G. W., 1984. Structure of the female reproductive tract of the apple snail. II. Scanning electron microscopy. *Tissue and Cell*, 16 (1): 107-114.

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Four new *Euthria* (Mollusca, Buccinidae) from the Cape Verde archipelago, with comments on the validity of the genus

Cuatro nuevas *Euthria* (Mollusca, Buccinidae) del archipiélago de Cabo Verde con comentarios sobre la validez del género

Emilio ROLÁN* António MONTEIRO** and Koen FRAUSSEN***

Recibido el 2-XII-2002. Aceptado el 22-I-2003

ABSTRACT

Four species, collected in the Cape Verde Islands, are described as new and assigned to the genus *Euthria* M. E. Gray, 1830. The new species are compared with other taxa from the Mediterranean Sea and the Cape Verde Archipelago. The genera *Euthria*, and *Buccinulum* are compared and the significance of the differences between them is discussed, leading to the conclusion that both genera are valid and should be kept separated.

RESUMEN

Se describen cuatro especies nuevas del género *Euthria* M. E. Gray, 1830 recogidas en aguas circalitorales del archipiélago de Cabo Verde. Las nuevas especies son comparadas con otros taxones congenéricos existentes en el Mediterráneo y en el propio archipiélago. Recientemente, el género *Euthria*, únicamente conocido del Atlántico oriental, ha sido sinonimizado con *Buccinulum*, que posee especies en el Indo-Pacífico, por lo que se comparan ambos géneros y se discute el valor de las diferencias entre ellos, considerando finalmente que ambos son válidos, y deben mantenerse separados.

KEY WORDS: *Euthria*, *Buccinulum*, Cape Verde Archipelago, new taxa.
PALABRAS CLAVE: *Euthria*, *Buccinulum*, Archipiélago de Cabo Verde, nuevos táxones.

INTRODUCTION

During the last few years, the genus *Euthria* Gray, 1850 has frequently been considered as a synonym of *Buccinulum* Deshayes, 1830 (BEETS, 1985, SABELLI, GIANNUZZI-SAVELLI AND BEDULLI, 1990, POPPE AND GOTO, 1991, BOUCHET, LE RENARD AND GOFAS, 2001, CHIARELLI, 2002), but regarding the differences between both genera we suggest to keep them separate, as commented upon in "Remarks" of this paper.

The genus *Euthria* is represented in the Mediterranean Sea by a single species, *Euthria cornea* (Linné, 1758), which is rather variable. On the contrary, several species have been described, by DAUTZENBERG AND FISCHER (1906), COSEL (1982b), COSEL

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Figure 1. *Euthria saharica*. Original representation of the holotype (from LOCARD, 1897).
Figura 1. Euthria saharica. *Representación original del holotipo (de LOCARD, 1897).*

AND BURNAY (1983) and ROLÁN (1985), for the Cape Verde Archipelago, and a revision of the genus has been published by ROLÁN (1987).

In addition to the species from the Mediterranean and from Cape Verde, LOCARD (1897) has described *Euthria saharica* (Fig. 1), MARCHE-MARCHARD AND BREBION (1977) have described *Euthriostoma gliberti*, both from the western coast of Africa. These species have a more fusiform shell, with an elongated siphonal channel, that it is we consider it doubtful that they belong to the genus *Euthria* at all. BOUCHET AND WARÉN (1986) have placed these species in synonym together with *Metzgeria apodema* Bouchet and Talavera 1981, considering it is not an *Euthria*. GUERREIRO AND REINER (2000) show some shells belonging to this genus that do not match the ones previously known for the archipelago and identify them as *E.* cf. *saharica* and *E. cornea*. ROLÁN (in press), in a review of the Cape Verde gastropod fauna, mentions these references, but states that it is unlikely that the proposed identifications are correct.

The present paper is based on material obtained during the last few years by César Fernandes. This material has been dredged from deep waters in different points of the Archipelago.

Abbreviations:

MNCN Museo Nacional de Ciencias Naturales, Madrid

CCF collection of César Fernandes, Cascais

CER collection of E. Rolán, Vigo

SYSTEMATICS

Genus *Euthria* M. E. Gray, 1850

Type species: *Buccinum corneum* Linné, 1758. Recent, Mediterranean. Original designation: "*Fusus lignarius* Chiaje" (this is *Fusus lignarius* Lamarck, 1816, a junior synonym of *Murex corneus* Linnaeus, 1758).

Description: GRAY (1850): "Teeth, central 1 large, lateral 1-1, versatile. Muzzle rectactile. Operculum annular. Siphon of mantle produced in front" for

the family; "Operculum ovate, acute; nucleus apical. Varices of shell rudimentary or none" for the group to which belong; and, finally "Canal elongate" for the genus. THIELE (1935): "Shell spindle-shaped, with high, ribbed spire; aperture oval; canal in most cases fairly long, somewhat oblique. Operculum with terminal nucleus".

Remarks: All Recent *Euthria* species have a more or less conspicuous subsutural depression or concavity (*E. rolani* von Cosel, 1982, ornamented with a thick and rather bulbous suture, being an exception); they have some axial sculpture on the upper whorls, and lack well developped spiral sculpture but occasionally show some fine cords or striae (the only exception being *E. effendyi* [see FRAUSSEN, 2002] - of which we have no radula available - to ensure the generic placement, an Indonesian species which is closely related to the fossil fauna).

The radula of *Euthria*, consisting of 3 teeth (1 middle, 2 lateral) with each 3 cusps, is typical for Buccinidae. The form of the middle tooth (triangular with the cusps on the broad upper corner) (IREDALE 1917, COOKE 1917, SHUTO 1978, ROLÁN 1987), is shared with *Euthriostoma* Marche-Marchard and Brebion, 1977 (Fraussen, unpublished) and *Afer* Conrad, 1858 (FRAUSSEN and HADORN 1999).

The radula of *Buccinulum* is similar in general aspects but differs by a somewhat broader, lesser triangular central tooth with more rounded margins (COOKE 1917). We can base this comparison on a limited number of species only, as a more thoroughfull study of the radula of all New Zealand species is beyond the limit of the present paper. Further study probably can bring more light on the eventual presence of *Euthria* species among the buccinulums of New Zealand.

The radulae of *Siphonofusus* KURODA AND HABE, 1954 and *Afrocominella* IREDALE, 1918 are similar too, but differ by the quadrangular middle tooth with rather sharp corners (COOKE, 1917, BARNARD, 1959).

The type species of *Buccinulum* (*B. lineum* Martyn, 1784) (Figs. 29-31), and consequently other Pacific species included in the same genus, doubtlessly have a certain morphological resemblance to the Atlantic species of *Euthria*. Conchological differences between *Euthria* and *Buccinulum* are rather slight, but we must recognize the presence of somewhat prominent axial ribs on the upper whorls and a clear subsutural concavity in *Euthria*. The material of which the shell of *Buccinulum* is produced will be an interesting matter for further study, as the surface is not as smooth and brilliant as in *Euthria*, which is rather glossy, especially in the Indo-West Pacific.

We agree with BEETS (1986) to consider the Indonesian archipelago as the geological center of *Buccinulum* and *Euthria*. In the Recent fauna we can recognize 4 important geographical areas: the important radiation of *Buccinulum* around New Zealand (differentiated from typical *Euthria* already early in history during the Tethys Sea), an *Euthria* radiation along the coasts of the Indian Ocean, another on the lower shelf around New Caledonia and, finally, the East Atlantic *Euthria* - *Euthriostoma* - *Afer* radiation (separated from the main group during the split of the Tethys Sea). The species described as new in the present paper are an addition to this latter group.

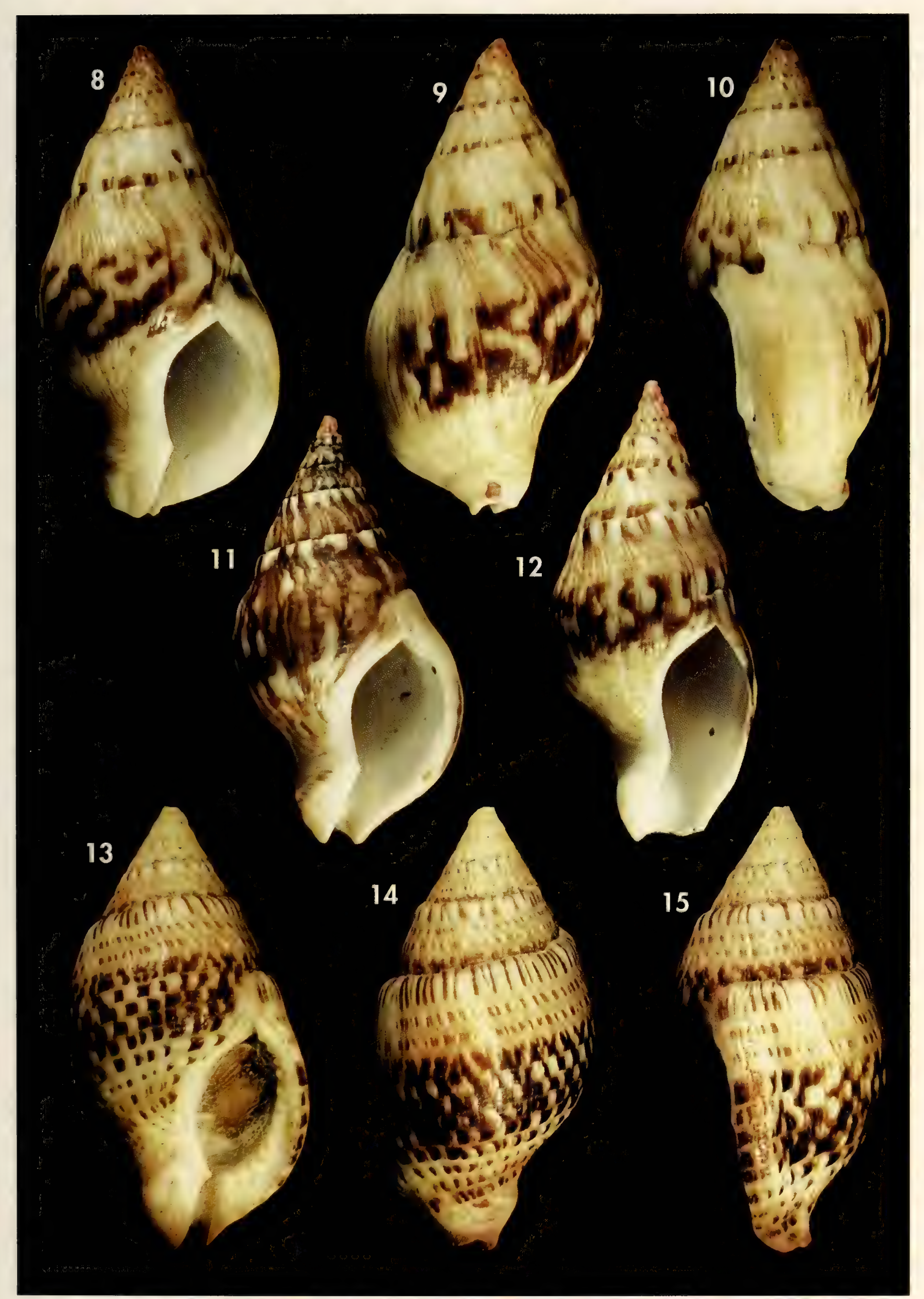
Regarding the difference in radula, geographic-geological separation and a number of slight conchological differences cited above, we consider the genera *Euthria* and *Buccinulum* as being different and keep them separate.

Euthria soniae spec. nov. (Figs. 2-7, 23B, 25A, 28E)

Type Material: Holotype (Figs. 2-4) in MNCN (15.05/46582). Paratypes in: CCF (1, Fig. 5), CER (1, Fig. 6), MNHN (1, Fig. 7).



Figures 2-7. *Euthria soniae*. 2-4: Holotype, 53.3 mm, Cape Verde archipelago (MNCN); 5: Paratype, 46.3 mm (CCF). 6: Paratype, 47.2 mm (CER). 7: Paratype, 50.2 mm (MNHN).
Figuras 2-7. Euthria soniae. *2-4: Holotipo, 53,3 mm, archipiélago de Cabo Verde (MNCN); 5: Paratipo, 46,3 mm (CCF). 6: Paratipo, 47,2 mm (CER). 7: Paratipo, 50,2 mm (MNHN).*



Figures 8-12. *Euthria marianae*. 8-10: Holotype, 36.9 mm, between São Vicente and São Nicolau, CV (MNCN). 11: Paratype, 33.4 mm (CCF). 12: Paratype, 35.3 mm (CER). Figures 13-15. *Euthria* cf. *marianae*. Concha, 34.0 mm, between São Vicente and São Nicolau, CV (CCF).
Figuras 8-12. Euthria marianae. *8-10: Holotipo, 36,9 mm, entre São Vicente y São Nicolau, CV (MNCN). 11: Paratipo, 33,4 mm (CCF). 12: Paratipo, 35,3 mm (CER). Figuras 13-15.* Euthria cf. marianae. *Concha, 34.0 mm, entre São Vicente y São Nicolau, CV (CCF).*

Type locality: Cape Verde Archipelago. The type material was donated by Capeverdian fishermen without exact information. It is however likely that it was captured in "barlavento" group of islands.
Derivatio nominis: The new species is named after biologist Sonia Elsy Merino, who has dedicated herself to the study and conservation of the marine fauna, working in Porto Mindelo, São Vicente, Cape Verde Archipelago, and who has cooperated with our research.

Description: Shell (Figs. 2-7) ovoid-fusiform and solid. The protoconch (Fig. 23B, 25A, 28E) is yellowish, with 1 $^3/_4$ - 2 spiral whorls and a diameter of about 1.7 mm. Teleoconch with 7 rapidly increasing whorls. The whole spire presents axial ribs, 9 - 10 in number on first whorl, 10-12 on last whorl. Subsutural ramp strongly depressed. Aperture ovoid, white, with 12-13 internal folds visible at the internal part of the peristome; it is continued with a narrow and slightly curved siphonal canal. Yellowish to brown undulated axial flammules, sometimes coalescing, and even forming a reticulated pattern, appear on a white background.

Holotype 53.3 mm x 21.1 mm. The paratypes are slightly smaller, the smallest one being 46.3 mm long.

Soft parts unknown.

Distribution area: The species is known only from the Cape Verde Archipelago. The short protoconch suggests an insular endemism.

Comparison: The present species must be compared with *E. cornea*, which has a similar profile, but is sometimes larger, [easily up to 65 mm, but also larger: 84,7 mm in F. Pusateri collection, Palermo, and SETTEPASSI (1971) records the maximum size known at 88 mm]. *E. cornea* has axial nodules on the first 4-5 spiral whorls, rarely on the last one. The main difference is the protoconch, which in *E. cornea* (Figs. 23A, 28A) has a little more than 1 whorl, with about 0.8 mm, and in *E. soniae* (Fig. 23B, 28E) has between 1 $^3/_4$ and 2 whorls, with about 1.7 mm of diameter.

Euthria marianae spec. nov. (Figs. 8-12, 24B, 28C)

Type material: Holotype (Figs. 8-10) in MNCN (15.05/46583). Paratypes in: CCF (1, Fig. 11), CER (1, Fig. 12).
Type locality: Between São Nicolau and São Vicente, at a depth of 75 - 150 m, in the Cape Verde Archipelago.
Derivatio nominis: The new species is named after Mariana, the grand daughter of César Fernandes - a well-known Portuguese collector who has greatly contributed to the knowledge of the malacological faunas of the Cape Verde Islands and of Mozambique - and the daughter of César Fernandes Jr., a keen diver and shell hunter.

Description: Shell (Figs. 8-12) ovoid-fusiform and solid. The protoconch (Figs. 24B, 28C) is pink, with between 1 $^3/_4$ and 2 spiral whorls and a diameter of about 1.5 mm. Teleoconch with about 6 rapidly increasing spiral whorls, with weak undulating axial ribs, present on the whole shell, 11 on the first whorl, 16 on the last whorl. Subsutural ramp slightly depressed, suture nodulous. Aperture ovoid, white, with about 11 teeth in inner part, continued with internal folds; the aperture extends into a narrow, elongated and curved siphonal canal. Background colour white, with a brown band with white blotches on the last whorl; this band is visible on previous whorls on a short part on the suprasutural area.

The holotype mesures 36.9 x 19.1 mm. The paratypes are of similar size.

Soft parts unknown.

Distribution area: The species is known only from locations between S. Nicolau e S. Vicente, at 75 - 150 m of water, taken from traps.

The short protoconch suggests an insular endemism.

Comparison: The present species must be compared with *E. rolani* Cosel, 1982

and *E. boavistensis* Cosel, 1982, which have similar aspects. *E. rolani* was collected near Santa Luzia in shallow water, and the shell is more globose and solid, the aperture is pink-violet instead of white, the subsutural area is not depressed, the colour pattern is different, with wide blotches, and the protoconch is wider and dark brown (Figs. 24A, 27, 28B), about 2.1 mm in diameter. *E. boavistensis* has a smaller shell, with a different, more irregular, colour pattern, the aperture constantly pink and the protoconch a little smaller (about 1.2 mm diameter).

Euthria fernandesi spec. nov. (Figs. 16-18, 28B, 28D)

Type material: Holotype (Figs. 16-18) deposited in MNCN (15.05/46584).
Type locality: Dredged between the islands of Maio and Boavista, at 75 - 125 m, Cape Verde Archipelago.
Derivatio nominis: The new species is named after the well-known Portuguese shell collector César Fernandes.

Description: Shell (Figs. 16-18) ovoid-fusiform and solid. The protoconch (Figs. 25B, 28D) is white, with a little more than 2 spiral whorls and a diameter of 2.2 mm. Teleoconch with 6 rapidly increasing spiral whorls, with axial ribs on the whole shell, 10 on the first whorl, 16 on the last whorl; these ribs are present at the suture, giving it a nodulous aspect. Subsutural ramp strongly depressed. Aperture ovoid, white, with 13 folds on its outer lip; the aperture extends into a narrow, slightly elongated and dorsally curved siphonal canal. The background colour is irregular light brown, with numerous small axial white lines; there is a suprasutural broad dark brown spiral band, interrupted by white blotches, and other similar but less conspicuous bands towards the anterior end of the shell.

The holotype is 51.3 mm x 22.6 mm.

Soft parts unknown.

Distribution area: The species is only known from the type locality

The short protoconch suggests an insular endemism.

Comparison: Only the holotype is available, but we decide to describe this species, because of important differences with other congeneric species.

E. fernandesi spec. nov. must be compared with *E. cornea*, and it may be separated because the latter species does not have the conspicuous coloured bands, and the last whorls usually lack axial and spiral sculpture. Furthermore, the protoconch has only one whorl, it is cream or light brown, and its diameter is smaller (only 0.8 mm in diameter, versus 2.1 mm in the new species).

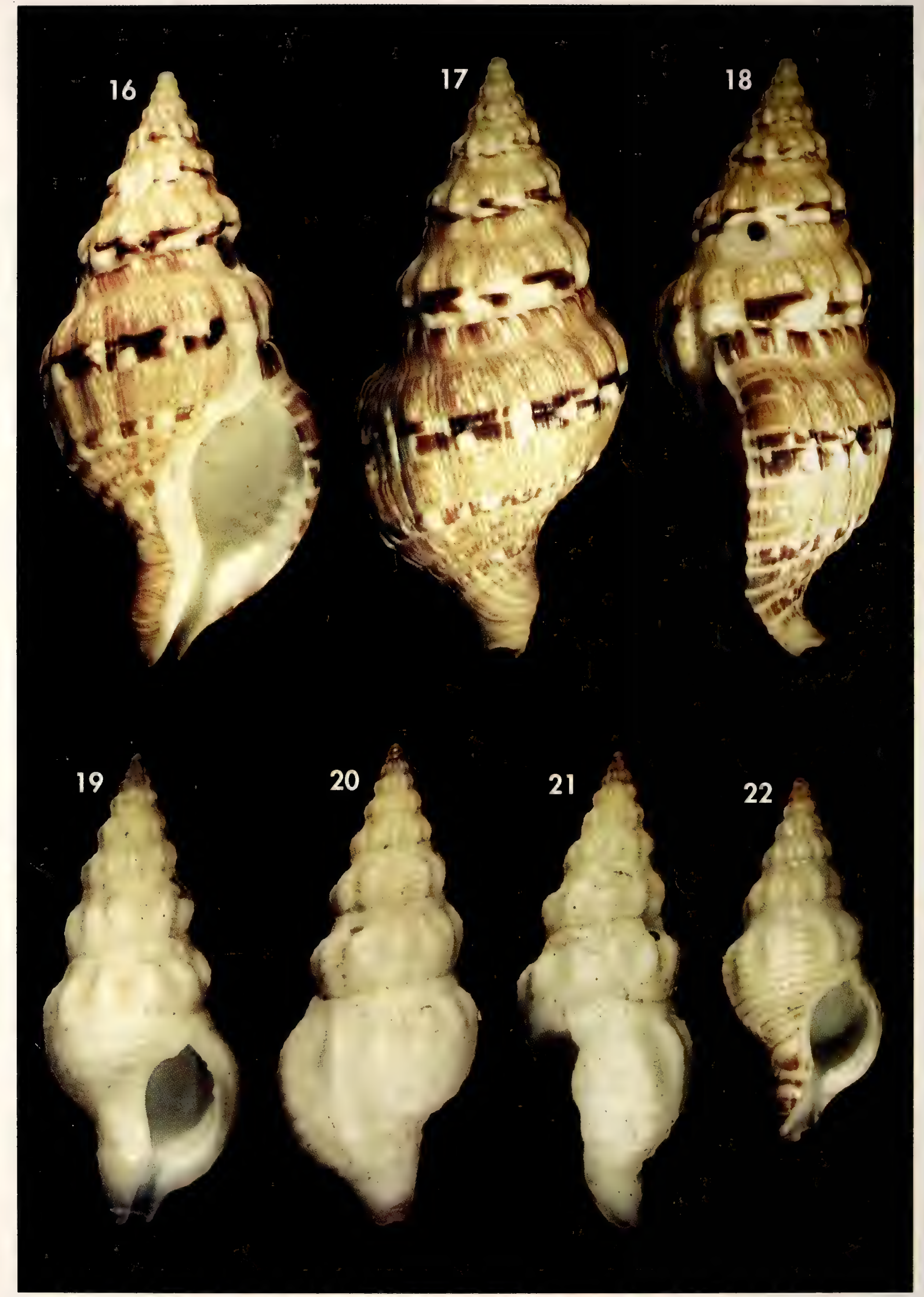
E. calypso Cosel and Burnay, 1983 has a similar size, but the shell pattern is different, with spiral blotches only, more evident on the suture, and lacking axial sculpture, except in the first whorls of the teleoconch. Its spiral sculpture is formed by spiral threads, which are evident on the first whorls only, and the subsutural depression is less evident. The whorls are less convex.

E. pulicaria Dautzenberg and Fischer, 1906 has a smaller, less elongated shell, with a small subsutural depression but prominent suture, a different colour pattern and a smaller siphonal canal.

E. soniae spec. nov. lacks spiral sculpture, has a more elongated spire, the colour pattern is formed by axial flammules without any spiral banding, and the protoconch is smaller and yellowish (instead of white).

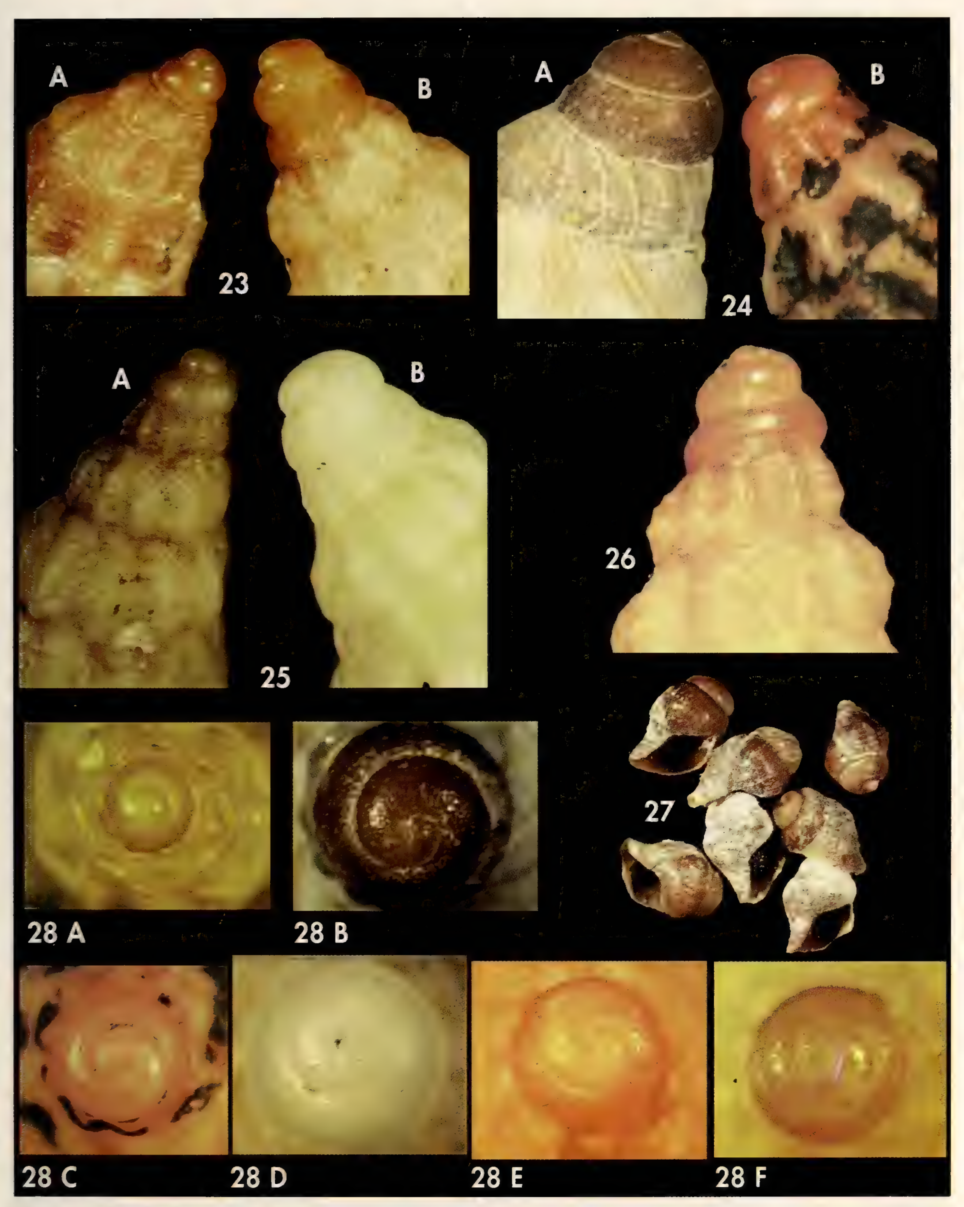
Euthria helenae spec. nov. (Figs. 19-22, 26, 28F)

Type material: Holotype (Figs. 19-21) in MNCN (15.05/46585). Paratypes in: CCF (1, Fig. 22), CER (1).
Type locality: Between São Nicolau and São Vicente, at 75 - 125 m depth, Cape Verde Archipelago.



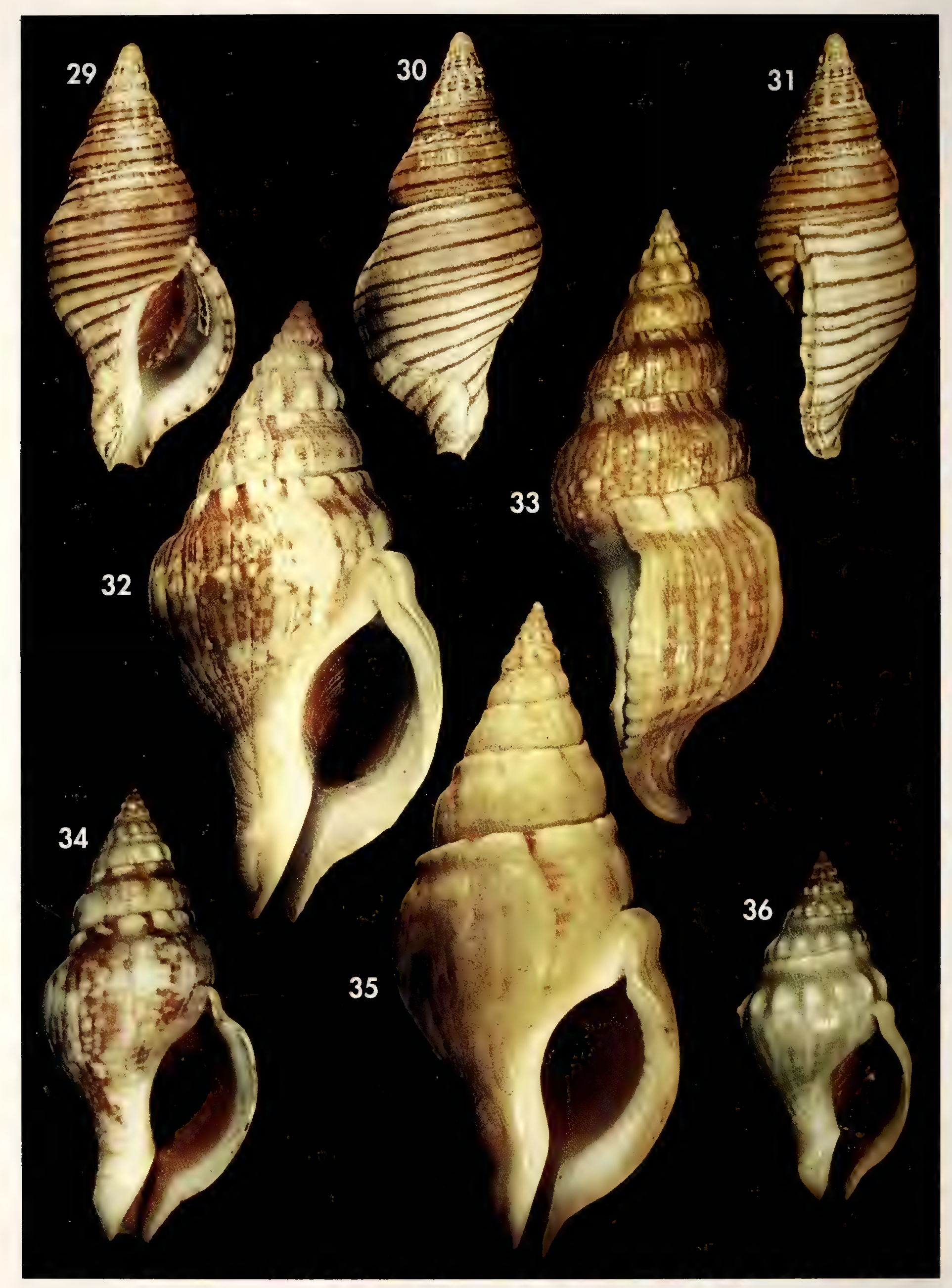
Figures 16-18. *Euthria fernandesi*. Holotype, 51.3 mm, between São Nicolau and São Vicente, CV (MNCN). Figures 19-22. *Euthria helenae*. 19-21: Holotype, 40.2 mm, between São Nicolau and São Vicente, CV (MNCN); 22: Paratype, 25.4 mm, (CCF).

Figuras 16-18. Euthria fernandesi. *Holotipo, 51,3 mm, entre São Nicolau y São Vicente, CV (MNCN). Figuras 19-22.* Euthria helenae. *19-21: Holotipo, 40,2 mm, entre São Nicolau y São Vicente, CV (MNCN); 22: Paratipo, 25,4 mm, (CCF).*



Figures 23-28. Comparison at same magnification between the protoconchs of *E. cornea* (A) and *E. soniae* (B); 24: Comparison at same magnification between the protoconchs of *E. rolani* (A) and *E. marianae* (B); 25: Comparison at same magnification between the protoconchs of *E. soniae* (A) and *E. fernandesi* (B); 26: Protoconch of *E. helenae;* 27: Larval shells of *E. rolani* before hatching; 28: Comparison at same magnification between the protoconchs of *E. cornea* (A), *E. rolani* (B), *E. marianae* (C), *E. fernandesi* (D), *E. soniae* (E) and *E. helenae* (F).

Figuras 23-28. Comparación al mismo aumento entre las protoconchas de E. cornea *(A) y* E. soniae *(B); 24: Comparación al mismo aumento entre las protoconchas de* E. rolani *(A) y* E. marianae *(B); 25: Comparación al mismo aumento entre las protoconchas de* E. soniae *(A) y* E. fernandesi *(B); 26: Protoconcha de* E. helenae*; 27: Conchas larvarias de* E. rolani *antes de la eclosión; 28: Comparación al mismo aumento entre las protoconchas de* E. cornea *(A),* E. rolani *(B),* E. marianae *(C),* E. fernandesi *(D),* E. soniae *(E) y* E. helenae *(F).*



Figures 29-31. *Buccinulum lineum*, 35.5 mm, New Zealand (CER). Figures 32-36. *Euthria cornea*. 32: Shell, 51.2 mm, Faro, Algarve, Portugal (CER); 33: Shell, 50.6 mm, Cabo de Palos, Murcia, Spain (CER); 34: Shell, 37.9 mm, Malta (CER); 35; Shell, 54.7 mm, Sokakagzi, Turkey, 125 m (CER); 36: Shell, 29.2 mm, Karaade Island, South of Bofrum, Turkey (CER).

Figuras 29-31. Buccinulum lineum, *35,5 mm, Nueva Zelanda (CER). Figuras 32-36.* Euthria cornea. *32: Concha, 51,2 mm, Faro, Algarve, Portugal (CER); 33: Concha, 50,6 mm, Cabo de Palos, Murcia, Spain (CER); 34: Concha, 37,9 mm, Malta (CER); 35: Concha, 54,7 mm, Sokakagzi, Turquia, 125 m (CER); 36: Concha, 29,2 mm, isla Karaade, sur de Bofrum, Turquia (CER).*

Derivatio nominis: The new species is named after Helena Monteiro, the wife of the second author, who for many years has endured long hours of malacological discussion at home, long sessions of shell collecting and bad smelling jars about the house. All shell collectors' wives deserve great tribute.

Description: Shell (Figs. 19-22) ovoid-fusiform and solid. The protoconch (Figs. 26, 28F) is light brown, with 2 $^1/_4$ spiral whorls and a diameter of about 1.6 mm. Teleoconch with 7 rapidly increasing spiral whorls, with axial ribs on the whole shell, 9-10 on the first whorl, 12 on the last one; these ribs do not reach the lower suture and disappear towards the base. The subsutural ramp is strongly depressed. 4-5 main spiral threads on the first whorls, 18 on the last one; between them there are other smaller threads, only visible under magnification. Aperture ovoid, white, with 11 internal folds at the external part; the aperture extends into a narrow slightly elongated and curved siphonal canal. Colour whitish cream, except for the protoconch and the first two whorls of the teleoconch, which are brown. The tip of the siphonal canal is also dark in the holotype. The two paratypes are ornamented with dark blotches at the base and brown colour in the spaces between the lower spiral cords.

Dimensions: Holotype is 40.2 x 17.3 mm.

Soft parts unknown.

Distribution area: The species is known only from the type locality, collected in traps.The short protoconch suggests an insular endemism.

Comparison: The present species has spiral threads and a deep suture as its main characteristic, and so we will compare it with other species with a similar sculpture.

E. pulicaria has a smaller, more globose and shorter shell; the suture is prominent instead of deep, the subsutural depression is scarcely noticeable and it is ornamented with a brownish banded pattern.

E. adeles Dautzenberg and Fischer, 1906 has a smaller shell, with a shallower suture, the profile of the last whorl lesser convex, and a shorter siphonal canal.

E. calderoni has a smaller, narrower, more elongate shell, with variable colour, smaller protoconch and variable apertural colour.

REMARKS

As far as the specific separation is concerned, we have had the possibility of examining large samples of the type species, *E. cornea*. This species seems to be present only in the Mediterranean Sea - Tanger being the most western location mentioned by PASTEUR-HUMBERT (1962) in his study of the fauna from Morocco - and, to the North, it reaches the Atlantic, being present at Algarve, on South Portugal (pers. inf.). It is usually found in shallow waters, but has also been taken from depths of over 100 m. Within its geographical range, the species presents a wide morphological variability (Figs. 32-36), which even made ROLÁN (1987) consider the possibility that more than one species could be under hand. However, and despite the mentioned variability, all specimens show a short protoconch (Figs. 23A, 28A), with a single spire whorl, of a cream colour and a diameter of about 0.8 mm.

Among the species known from Cape Verde, the great morphological variability in the shells of *E. calderoni* has already been stressed (see ROLÁN, 1987), and it will be documented in further studies (ROLÁN, in press). But the examination of the protoconch and of juveniles - in ages close to hatching - has shown that a great intraspecific similitude in the larval shells exists, as well as a great interspecific separation, which made comparison with the newly found species, all of them easy to distinguish from *E. cornea*.

So, it is obvious that our knowledge about this genus in the Cape Verde Islands has grown a lot in the last few years, from the three species mentioned by VON COSEL (1982a) to the ten presently known species. But some material waiting further study

Table I. Morphological characteristics of *Euthria* species. 1: maximum length for the species, in mm; 2: axial sculpture on the last whorls, from – to ++; 3: spiral sculpture on the last whorls, from – to ++; 4: colour of inner aperture; 5: colour of protoconch; 6: diameter of protoconch, in mm; 7: number of whorls in the protoconch.
Tabla I: Características morfológicas de las especies de Euthria. *1: máxima longitud de la especie, en mm; 2: escultura axial de las últimas vueltas, de - a ++; 3: escultura espiral de las últimas vueltas, de - a ++; 4: color de la apertura interna; 5: color de la protoconcha; 6: diámetro de la protoconcha, en mm; 7: número de vueltas de la protoconcha.*

	1	2	3	4	5	6	7
E.cornea	88	+-	-	from white to dark brown	light brown	0.8	1 1/8
E. adeles	30	++	+	whitish	brown	?	1?
E. pulicaria	36	++	+	white	pink	?	1?
E. rolani	41	-	-	pink to purple	brown	2.1	2-2 1/4
E. boavistensis	31	-	-	pink to purple	pink	1.2	2
E. calypso	44	-	+-	white	?	?	2
E. calderoni	18	+	+	colour of shell	colour of shell	1.3	2
E. soniae	53	+	-	white	yellowish	1.7	1 3/4-2
E. marianae	37	+	-	white	pink	1.5	1 3/4-2
E. fernandesi	51	++	++	white	white	2.2	2
E. helenae	40	++	+	white	brown	1.6	2 1/4

can involve the discovery of even more undescribed species.

For an easier grasp of the *Euthria* species, we schematically present a few morphological characteristics, in Table I.

Although all the species were collected in the Cape Verde Islands, it is probable that their distribution range does not include the whole archipelago, and also that they have different habitats and depth ranges. Table II shows a summary of this information.

ACKNOWLEDGEMENTS

The authors thank Jesús S. Troncoso, from the Universidad de Vigo, in whose Departamento de Ecología the photos of the present work were made.

Table II. Known distribution area and depth range of the studied species of the genus *Euthria*.
Tabla II. Área de distribución conocida y rango de profundidad de las especies de Euthria *estudiadas.*

	Known distribution area	Depth range
E. .cornea	Mediterranean and South Portugal	shallow water
E. adeles	CV, Santa Luzia	– 52 m
E. pulicaria	CV, Boavista	– 91 m
E. rolani	CV, Santa Luzia	shallow water
E. boavistensis	CV, Boavista	shallow water
E. calypso	CV, between Boavista & Maio	–100 to – 200 m
E. calderoni	CV, all of the Archipelago	shallow water to – 30 m
E. soniae	CV, Barlovento group	– 100 m?
E. marianae	CV, between São Nicolau & São Vicente	– 75 to – 150 m
E. fernandesi	CV, between Maio & Boavista	– 75 to – 125 m
E. helenae	CV, between São Nicolau & São Vicente	– 75 to – 150 m

BIBLIOGRAPHY

BEETS, C., 1986. Notes on *Buccinulum*, a reappraisal. *Scripta Geol.* 82: 83-100.

BARNARD, K. H., 1959. Contributions to the knowledge of South African marine Mollusca. Part 2. Gastropoda: Prosobranchiata: Rachiglossa. *Annals of the South African Museum*, 45 (1): 1-237.

BOUCHET, PH. AND WARÉN, A., 1986 "1985". Mollusca gastropoda: Taxonomical notes on tropical deep water Buccinidae with description of new taxa. *In*: Résultats des Campagnes MUSORSTOM. I and II. Philippines, tome 2. *Mémoires du Musèum Natural d'Histoire Nattural*, sér.A, Zool., 133: 457-499.

BOUCHET, PH., LE RENARD, J. AND GOFAS, S., 2001. Mollusca: pp 180-213. In Costello, M. J., Emblow, C. and White, R. (editors). *European Register of Marine Species. A check-list of the marine species in Europe and a bibliography of guides to their identification.* Publication Scientifiques du Musèum National d'Histoire Naturelle.

CHIARELLI, S., 2002. *Nuovo catalogo delle conchiglie marine del Mediterraneo.* Società Italiana di Malacologia. No pagination.

COOKE, A. H., 1917a. The radula of the genus *Cominella*, H. and A. Adams. *Proceedings of the Malacologiczal Society, London*, 7: 225-231.

COOKE, A. H., 1917b. The radula of the genus *Euthria*, Gray. *Proceedings of the Malacologiczal Society, London*, 7: 232-235.

COSEL, R. VON, 1982a. Marine Mollusken der Kapeverdischen Inseln. Übersicht mit zoogeographischen Anmerkungen. *Courier Forschungsinst, Senckenberg*, 51: 35-76.

COSEL, R. VON, 1982b. Zwei neue *Euthria*-Arten von den Kapverdischen Inseln (Prosobranchia: Buccinidae). *Archiv für Molluskenkunde*, 112 (1-6): 157-163.

COSEL, R. VON AND BURNAY, L. P., 1983. A new *Euthria* from deeper shelf of the Cape Verde Islands. *Archiv für Molluskenkunde*, 113 (1-6): 151-157.

DAUTZENBERG, PH. AND FISCHER, H., 1906. Mollusques provenant des dragages effectués a l'ouest de l'Afrique pendant les campagnes de S. A. S. le Prince de Monaco, 32: 1-125, pls. 1-5, *in* Richard, M. J. (ed.), *Résultats des Campagnes Scientifiques accomplies sur son yacht par Albert 1er Prince Souverain de Monaco.* Imprimerie de Monaco, Monaco.

FRAUSSEN, K., 2002. A new *Euthria* (Gastropoda: Buccinidae) from Java (Indonesia). *Gloria Maris*, 41 (4-5): 105-111.

FRAUSSEN, K. AND HADORN, R., (in press). Six new Buccinidae (Mollusca: Gastropoda) from New Caledonia. *Novapex.*

GRAY, M. E., 1850. *Figures of molluscous animals selected from various authors.* Vol. 4. Longman, Brown, Green and Longmans, London. pp. 219.

HADORN, R. AND FRAUSSEN, K., 1999. Transfer of *Afer* Conrad, 1858 to Buccinidae (Neogastropoda) with description of a new species from western Africa. *Gloria Maris*, 38 (2-3): 28-42.

GUERREIRO, A. AND REINER, F. 2000. *Moluscos marinhos da ilha de S. Vicente (Archipélago de Cabo Verde).* Câmara Municipal de Oeiras, Europress, Póvoa de Santo Adrião. 279 pp.

IREDALE, T., 1918. Molluscan nomenclatural problems and solutions.-No.1. *Proceedings of the Malacological Society, London*, 13: 28-33.

KURODA, T. AND HABE, T., 1954. New Genera of Japanese Marine Gastropods. *Venus*, 18 (2): 84-97.

LOCARD, A., 1897. Mollusques Testacés: 1, 1-516, in Milne-Edwards A. (Ed.). *Expéditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883. Mollusques testacés.* Bd. I: 516.

PASTEUR-HUMBERT, C., 1962. Les mollusques marins testacés du Maroc. I- Les Gastéropodes. *Travaux de l'Institut Scientifique Chérifien*, séries zoologique, 23: 1-245.

POPPE, G. T. AND GOTO, Y., 1991. *European Seashells.* vol. 1. Christa Hemmen, Wiesbaden. 352 pp.

POWELL, A. W. B., 1979. *New Zealand Mollusca. Marine land and Freshwater shells.* Collins, Auckland, 500 pp, 82 pls.

ROLÁN, E., 1985. A new *Euthria* of the Cape Verde Islands. *La Conchiglia*, 17 (190-191): 6-7.

ROLÁN, E., 1987. The species in the genus *Euthria.* (Mollusca: Gastropoda). *Argonauta*, 3 (5-6): 291-308.

ROLÁN, E., (in press). *Malacological Fauna from the Cape Verde Archipelago.* vol 1. Evolver, Roma.

SABELLI, B., GIANNUZZI-SAVELLI, R. and BEDULLI, D. 1990. *Catalogo annotato dei molluschi marini del mediterraneo*, 3 vols. Libreria Naturalista Bologna. 781 pp.

SETTEPASSI, F., 1977 "1971". *Atlante malacologico I. Molluschi marini viventi nel Mediterraneo.* vol II. Museo di Zoologia del Comune. Roma. without page numbers.

SHUTO, T., 1978. On the genera *Siphonofusus* and *Euthria* of the Indo-West Pacific. *Transactions and Proceedings of the Palaeontological Society, Japan*, New Series, 111: 358-369.

THIELE, J., 1929-1935. *Handbuch der systematischen Weichtierkunde.* Jena, 4 vol. 1154 pp.

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Contribución al conocimiento de la fauna malacológica miocénica de La Pedrera, Sant Llorenç d'Hortons (NE de la Península Ibérica)

Contribution to the knowledge of the Miocenic malacological fauna from La Pedrera, Sant Llorenç d'Hortons (NE of the Iberian Peninsula)

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Recibido el 3-VI-2002. Aceptado el 24-I-2003

RESUMEN

Se presenta una lista de 160 especies de moluscos marinos fósiles (138 gasterópodos, 19 bivalvos y 3 escafópodos), recolectados en el yacimiento del Mioceno medio de La Pedrera, en Sant Llorenç d'Hortons (Barcelona, NE de la Península Ibérica). De estas especies, 40 son citas nuevas para la Península Ibérica y, además, 29 primeras citas para el yacimiento. Se describen las siguientes nuevas especies: *Obtusella orisparvi, Caecum verai, Eulimella penedesensis, Noemiamea batllorii* y *Turbonilla olivellai.* Proponemos dos nuevos nombres para *Eulimella concinna* Sorgefrein, 1958 non Jeffreys, 1884 y *Odostomia modesta* Sorgefrein, 1958 non Stimpson, 1851. Se presta especial atención a los moluscos de pequeño tamaño que se han estudiado con mayor detalle. Se incluyen asimismo comentarios sobre algunos de los taxones mencionados y se muestran muchos de ellos al microscopio electrónico de barrido (MEB), con especial atención a la familia Pyramidellidae.

ABSTRACT

A list of 160 species of fossil marine molluscs (138 Gastropoda, 19 Bivalvia and 3 Scaphopoda) is presented. They were collected in the middle Miocene deposit of La Pedrera, Sant Llorenç d'Hortons (Barcelona, NE of the Iberian Peninsula). From these species, 40 are first record for the Iberian Peninsula, and 29 are first record for this deposit. The following new species are described: *Obtusella orisparvi, Caecum verai, Eulimella penedesensis, Noemiamea batllorii* and *Turbonilla olivellai.* We propose two new names for replacing: *Eulimella concinna* Sorgefrein, 1958 non Jeffreys, 1884 and *Odostomia modesta* Sorgefrein, 1958 non Stimpson, 1851. Special attention is paid to the smaller molluscs, studied detailly. Comments are done on some taxa previously mentioned and some of them are represented at SEM, mainly those of the Pyramidellidae family.

PALABRAS CLAVE: Moluscos marinos, Mioceno medio, La Pedrera, Sant Llorenç d'Hortons, NE Península Ibérica, micromoluscos, Pyramidellidae, taxonomía, nuevas especies.

KEY WORDS: Marine molluscs, middle Miocene, La Pedrera, Sant Llorenç d'Hortons, NE Iberian Peninsula, micromolluscs, Pyramidellidae, taxonomy, new species.

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INTRODUCCIÓN

El presente trabajo trata sobre los moluscos marinos que los autores han encontrado en el yacimiento miocénico del Burdigaliense superior-Langhiense (Batllori y Martorell, 1992) de La Pedrera, dedicando una especial atención a los micromoluscos, cuya abundancia ofrece material suficiente para realizar este trabajo. Por este motivo se ha utilizado una metodología especialmente dedicada a la recolección y estudio de este material.

Se trata de uno de los yacimientos más estudiados del Mioceno medio catalán, desde Almera (1896). Entre los numerosos trabajos realizados sobre este yacimiento, tanto desde el punto de vista geológico como paleontológico, destacamos los de Truyols y Crusafont (1951), Crusafont y Truyols (1954), Crusafont (1959), Casanovas, Calzada y Santafé (1972), Salaj (1972), Magné (1978), Martinell y Porta (1981), López-Civit (1984), Batllori (1990), Batllori y Martinell (1992), Batllori (1995) y Navas, Martinell, Domenech, y Batllori (1996).

Truyols i Crusafont (1951) hablan de la sedimentación transgresiva-regresiva del Mioceno del Vallès-Penedès; estudian una serie estratigráfica en la confluencia de la riera Rierussa con el río Anoia; y consideran que la edad del yacimiento de la Pedrera es Helveciense. Crusafont (1959) estudia la denominada segunda fase transgresiva, atribuyendo La Pedrera al período Tortoniense; la presencia de *Mytilus* y la ausencia de corales indicaría un ambiente de tipo estuario con fondos fangosos; también ofrece una lista de moluscos marinos; y mantiene que el yacimiento de La Pedrera es claramente Tortoniense. Casanovas *et al.* (1972) estudian la litología, sedimentología y paleontología de dos series de la Rierussa; admiten la entrada del mar por el Besós y que el Garraf sumergido actúa de barrera y favorece la sedimentación de elementos finos; y sugieren la existencia de una estructura tipo deltáica de edad Tortoniense. Salaj (1972) en un breve estudio microbioestratigráfico sobre las series de la Rierussa y La Pedrera, hechas por Truyols y Crusafont (1951), atribuye las capas basales de la primera localidad al Aquitaniense superior y el resto de capas de ambas localidades las atribuye al Burdigaliense y Tangiense inferior y superior. Magné (1978) ofrece la aportación quizá más importante en el campo de la cronología del Mioceno del Vallès-Penedès; estudia los foraminíferos y ostrácodos de numerosas localidades de la Depresión; y establece una nueva edad para el Mioceno de esta cuenca en la que los sedimentos marinos de la Pedrera pertenecerían al Langhiense. Martinell y Porta (1981) comentan la fauna encontrada en La Pedrera y basándose en el hallazgo de *Vaginella austriaca* atribuyen este yacimiento al Langhiense-Serravaliense inferior; consideran, además, que debido a la abundante presencia de Potamididae y Batillarididae el ambiente de La Pedrera es típico marino. López-Civit (1984) estudia los ostrácodos del Mioceno del Alt Penedés. Batllori (1990) realiza un estudio sistemático de los moluscos de La Pedrera. Batllori y Martinell (1992, 1993) estudian la actividad predadora en moluscos y consideran, además, en su comparación con el Mioceno salobre de Cerdanyola del Vallès, que los niveles de La Pedrera corresponden a unas facies marinas con claras influencias continentales. Batllori (1995) abunda especialmente en el estudio sistemático sobre los moluscos gasterópodos marinos del Alt Penedès. Navas *et al.* (1996), en base a los moluscos fósiles y criterios sedimentológicos, realizan una reconstrucción paleoambiental del sector de Sant Pau d'Ordal y de La Pedrera y deducen la equivalencia lateral de ambas localidades, a las que atribuyen una edad Langhiense-Serravaliense inferior. La presencia del opistobranquio *Vaginella austriaca* les induce a afirmar que durante este período existió una buena comunicación entre el golfo del Penedès y el mar abierto.

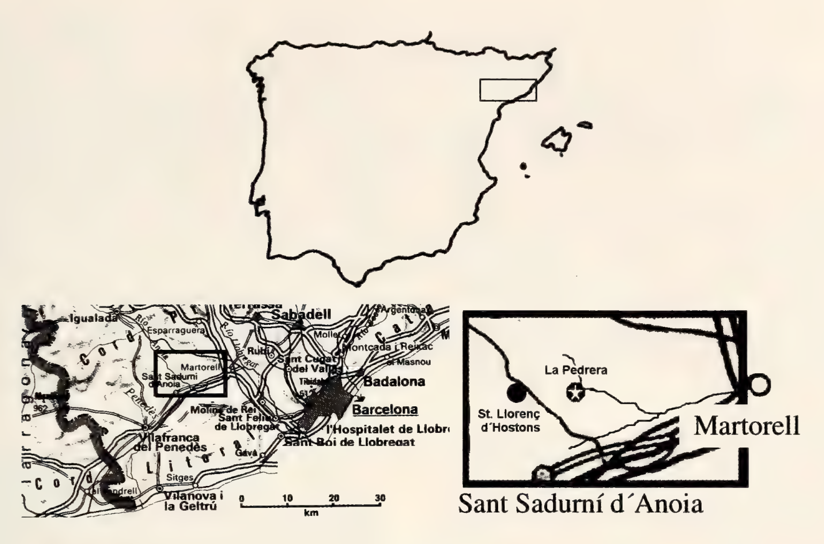


Figura 1. Situación geográfica de Sant Lorenç d'Hortons.
Figure 1. Geographical situation of Sant Llorenç d'Hortons.

ZONA DE ESTUDIO

El yacimiento de La Pedrera está situado al oriente de la localidad de Sant Llorenç d'Hortons, provincia de Barcelona, junto al torrente de La Rierussa, cerca de la masía de La Pedrera (Fig. 1).

Descripción de los niveles: MARTINELL Y PORTA (1981) diferencian por primera vez los niveles A y B de este yacimiento. El nivel A está formado por margas amarillas fosilíferas, asentadas sobre un nivel calizo arenoso. Sobre el nivel A se sitúa el nivel B que está formado por margas grisáceas, el cual se presenta más compactado. En el nivel A la fauna aparece concentrada levemente en finos estratos, caracterizados por la presencia de conchas de Pinnidae. Dentro del nivel A, se ha muestreado especialmente un estrato de una potencia máxima de 15 cm de morfología lenticular (Fig. 2). El material aparece en buen estado, aunque ofrece evidencias de haber sido levemente compactado, lo que hace que la fauna se presente fisurada en el interior del sedimento y aparezcan las conchas fragmentadas una vez lavado. En el nivel B el material se encuentra mejor conservado, presentando alguna vez trazas de la coloración original. Este nivel se encuentra más cementado, probablemente debido a la precipitación de carbonato procedente de la disolución de las conchas que contenían los niveles arenosos superiores. En este nivel el material aparece concentrado en lentejones.

MATERIAL Y MÉTODOS

La mayor parte del material estudiado procede del lavado de varias muestras, obtenidas mediante muestreo aleatorio sencillo, en un transecto de unos dos metros cuadrados aproximadamente. En el curso de diversos muestreos se han lavado un total de 265 kilos.

Todas las muestras, excepto 5 kilos recogidos en el nivel B, se tomaron en el nivel A. El nivel B del yacimiento clásico quedó enterrado, en Julio del 2000, tras unas lluvias torrenciales.

Una vez lavado el material y pasado por tres tamices, siendo el más fino de 300 micras de luz de malla, se recogieron unos 6,5 litros de sedimento conchífero y de otra fauna marina. La fracción fina, inferior a 2 mm, alcanzaba unos 3,5 litros.

Predominaban en ese sedimento conchas, valvas y restos de moluscos.

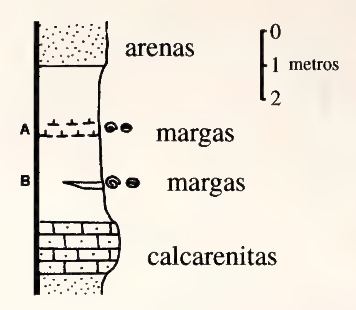


Figura 2. Posición estratigráfica de las muestras estudiadas en la sección de La Pedrera.
Figure 2. Stratigraphical position of the studied samples in La Pedrera section.

También eran comunes restos de cirrípedos (*Balanus*) y en menor medida restos de otra fauna marina: otolitos, espinas, vértebras y dientes de peces, pinzas de cangrejos, radiolas y placas de erizos, placas de asteroideos, el briozoo *Schizoporella unicornis* (Johnston in Wood, 1844), tubos de anélidos, ostrácodos, escasos foraminíferos y algún fragmento de coral.

También se han estudiado, aunque en escasa cantidad, ejemplares dejados al descubierto por la lluvia, tanto en los niveles A como B.

Se ha tratado de representar algunas de las especies no citadas anteriormente en este yacimiento y también aquellas sobre las que se aporta nueva información que consideramos de interés.Y se ha procurado fotografiar al MEB la mayoría de los micromoluscos. Las fotografías fueron realizadas por Jesús Méndez en el CACTI (Centro de Apoyo Científico y Tecnológico a la Investigación) de la Universidad de Vigo.

Para la descripción de la protoconcha de las especies pertenecientes a la familia Pyramidellidae se utilizará la nomenclatura de AARTSEN (1987) con las modificaciones adoptadas por LINDEN Y EIKENBOOM (1992) y SCHANDER (1994), y cuyas formas generales A-I, A-II , B y C, pueden verse representadas en PEÑAS, TEMPLADO Y MARTÍNEZ (1996) con puntualizaciones en su medición en PEÑAS Y ROLÁN (1999). De forma esquemática se pueden comentar: protoconchas de tipo A, con un ángulo alrededor de 90°-120° de desviación entre su eje y el de la concha, siendo A-I cuando es planispiral y A-II cuando es helicoidal; de tipo B, cuando este ángulo tiene entre 130°-160° y de tipo C cuando tiene aproximadamente 180°.

El listado de especies, a nivel supraespecífico, ha sido confeccionado, básicamente, siguiendo el orden taxonómico del CLEMAM (Check List of European Marine Mollusca) http://www.mnhn.fr/cgi-bin/mamlist.

La mayor parte del material aquí tratado, así como el sedimento conchífero y de otra fauna, ha sido depositado en la Sección de Paleontología del Museu del Vi, de Vilafranca del Penedès (Barcelona). Todo él está a disposición para ulteriores estudios.

En los pies de figura de las láminas, las medidas que se mencionan para los ejemplares allí representados se refieren a la máxima dimensión de cada concha.

Abreviaturas utilizadas:

c concha
f fragmento
v valva aislada
h altura de la última vuelta
H altura total de la concha
D diámetro de la concha
= aproximadamente igual
MGSB Museo Geológico del Seminario de Barcelona
MMP Museo Municipal Paleontológico, Estepona, Málaga
MNCN Museo Nacional de Ciencias Naturales, Madrid
MVV Museu del Vi, Vilafranca del Penedès, Barcelona

RESULTADOS

Se presentarán de la siguiente forma: en primer lugar un listado general de las especies aquí estudiadas. A continuación, en una segunda parte, se hará estudio más pormenorizado de algunas de estas especies, las cuales serán comentadas y muchas veces representadas. Finalmente, se hacen unos comentarios finales sobre la información existente previamente y la aportada en este trabajo y se termina con unas conclusiones.

1. Listado de especies

Se presenta en la Tabla I. En ella se indican las nuevas especies y/o citas, las figuras donde se representan en este trabajo y su abundancia.

2. Descripción, comentarios y representación de algunas especies nuevas o sobre las que se aporta nueva información.

De la mayoría de especies citadas previamente para La Pedrera existen fotografías y descripciones actualizadas en la literatura. En este apartado nos hemos limitado a referir solamente algunos de los taxones de la lista anterior que precisaban comentarios, ya fuese por su rareza, la escasa información existente sobre ellos, para aclarar anteriores determinaciones discutibles, o para describir aquellas nuevas especies para la ciencia. De algunas de estas especies aportamos fotografías, la mayoría de ellas al MEB.

Clase GASTROPODA

Teinostoma sp. (Figs. 14, 15)

Material examinado: 1 c.

Descripción: Concha diminuta, con un diámetro de 1,0 mm, sólida, muy brillante. Forma discoidal, muy aplanada, con la espira que queda oculta bajo la última vuelta. Escultura formada por tenues estrías espirales concéntricas en ambas caras. Abertura pequeña suboval. Débil callosidad basal. No umbilicada.

Comentarios: El ejemplar fotografiado procede del yacimiento miocénico cercano de "Can Rosell", Subirats, Barcelona, en el que la especie es común.

Bittium multiliratum Brusina, 1877

Bittium multiliratum Brusina, 1877. *Journ. Conchi.*, 25: 380.
Cerithidium sculptum Seguenza, 1880. *Mem. Cl. Sc. Fis., Mat. e Nat. R. Acc. Lincei*, 53, 6 (6): 109, lám. 11, fig. 16.

Material examinado: 3 c.

Descripción: En BALUK (1975) y en MORONI Y RUGGIERI (1988).

Dimensiones: 4,5 mm en 7 vueltas de la teloconcha.

Distribución cronoestratigráfica y geográfica: Mioceno inferior: Korytnika, Polonia (BALUK, 1975). Mioceno medio: Cuenca de Viena, Moravia y Hungría (BRUSINA, 1877); Mioceno medio (Langhiense): La Pedrera, Barcelona. Mioceno superior: Sicilia, Italia (MORONI Y RUGGIERI, 1988).

Comentarios: Nuestros ejemplares se corresponderían a la variedad *B. multiliratum saheloparvulum* (Moroni, 1955), caracterizada por tener 6-7 cordones espirales en la penúltima vuelta y la ausencia de escultura axial.

Tabla I. Listado general de las especies estudiadas en el presente trabajo. Especies en **negrita** son objeto de comentarios en el texto; (*): primera cita para el área de estudio; (**): primera cita para la Península Ibérica; (***): nueva especie para la ciencia o nombre específico nuevo (no se consideran citas ni especies nuevas para la zona o la Península aquellas que sólo se mencionan con el nombre del género sin denominación especifica); Fig: figura de este trabajo donde se representa esa especie (casi todo el material fotografiado procede de La Pedrera, en el texto se indican sólo las conchas fotografiadas que procedan del yacimiento cercano de Can Rosell, Subirats); f: sólo fragmentos; +: 1-2 ejemplares, ++: 3-10 ejemplares, +++: 11-100 ejemplares, ++++: más de 100 ejemplares; B: especie encontrada solamente en el nivel B.

Table I. General list of the species studied in this paper. Species in ***bold*** *are commented in the text; (*): first record in the studied area; (**): first record in the Iberian Peninsula; (***): new species or new specific name (those species only mentioned by its genre are not cosidered either new species in the area or the Iberian Peninsula); Fig: figure in this paper where the species is shown (almost all the photographed material comes from La Pedrera, in the text only the shells from the nearby Can Rosell deposit are indicated); f: only fragments; +: 1-2 specimens, ++: 3-10 specimens, +++: 11-100 specimens, ++++: more than 100 specimens, B: species found only in level B.*

Species	Fig		Abundancia	
Clase GASTROPODA				
Familia NERITIDAE				
* *Smaragdia picta* (Férussac, 1825)			+	
Familia SKENEIDAE				
** *Teinostoma defrancei* (Basterot, 1825)	Figs. 3-6		+++	
Teinostoma minimum Boettger, 1907	Figs. 7-10		+++	
Teinostoma woodi (Hörnes, 1856)	Figs. 11-13		++	
Teinostoma sp.	Figs. 14-15		+	B
Familia CERITHIIDAE				
Cerithium bronni Dollfus y Dautzenberg, 1886	Fig. 16		+	
Cerithium vulgatum Bruguière, 1792		f	+	
** ***Bittium multiliratum*** Brusina, 1877			++	
** *Bittium spina* (Hörnes, 1855)			++	
Familia SCALIOLIDAE				
Sandbergeria perpusilla (Grateloup, 1827)			++++	
Familia POTAMIDIDAE				
Potamides theodiscus (Rolle *in* Hilbert, 1879)			++++	
Familia BATILLARIDIDAE				
Granulolabium pictum (Basterot, 1825)			++++	
Familia TURRITELLIDAE				
Turritella bicarinata Eichwald, 1830			+++	
Turritella cf. *terebralis* Lamarck, 1822)			+++	
* *Turritella turris* Basterot, 1825		f	+	B
* *Turritella subangulata* (Brocchi, 1814)		f	+	
Protoma proto (Basterot, 1825)			++	
Protoma rotifera (Lamarck, 1804)			++	
** *Protoma vasconiensis* Cossmann y Peyrot, 1917			+	
Familia TRIPHORIDAE				
Monophorus perversus (Linné, 1758)			++	
Familia CERITHIOPSIDAE				
** ***Cerithiopsis minima*** (Brusina, 1865)	Figs. 17-19		+++	
** *Cerithiopsis lottae* Wienrich, 2001	Fig. 20		++	
Seila sp.			+	

Tabla I. Continuación.
Table I. Continuation.

Species	Fig		Abundancia
Familia ACLIDIDAE			
** *Graphis albida* (Kanmacher, 1798)		f	+
** *Aclis* cf. *ascaris* (Turton, 1819)			+
Familia EPITONIIDAE			
Epitonium sp.			++
Acrilloscala sp.			+
Familia EULIMIDAE			
* *Eulima glabra* (Da Costa, 1778)			+
* *Balcis alba* (Da Costa, 1778)			++
* *Niso terebellum* (Chemnitz, 1788)			+
Eulima sp.			+
Familia RISSOIDAE			
Rissoa sp.			++
***** *Obtusella orisparvi*** spec. nov.	Figs. 21-24		++++
Obtusella sp.			+
Familia ADEORBIDAE			
*** *Circulus striatus*** (Philippi, 1836)			++
Familia ELACHISINIDAE			
** ***Elachisina moravica*** (Rzehak, 1893)	Figs. 25-26		+++
Familia CAECIDAE			
***** *Caecum verai*** spec. nov.	Figs. 27-30		+++
Familia IRAVADIIDAE			
** *Chevallieria* cf. *peculiaris* (Boettger, 1901)			++
Familia HYDROBIIDAE			
** *Hydrobia peregrina* Boettger, 1901	Figs. 31-33		++++
Familia TORNIDAE			
* *Tornus belgicus belgicus* Baluk, 1975			+
* *Tornus planorbillus* (Dujardin, 1837)			+
**** *Discopsis belgicus*** Glibert, 1949	Figs. 34-36		+
**** *Discopsis canui*** (Morgan, 1920)	Figs. 37-39		+++
**** *Discopsis trigonostoma*** (Basterot, 1825)	Figs. 40-42		+++
Familia VERMETIDAE			
* *Vermetus granulatus* (Gravenhorst, 1831)			+
Serpulorbis arenarius (Linné, 1767)			++
Familia STROMBIDAE			
Tibia dentata ordalensis Almera y Bofill, 1886	Fig. 43		++
Dientomochilus decussatus (Defrance *in* Basterot, 1825)			+
Familia CALYPTRAEIDAE			
Calyptraea chinensis (Linné, 1758)			+++
Calyptraea ornata Basterot, 1825			+++
Crepidula unguiformis Lamarck, 1822			++
Familia CYPRAEIDAE			
Cypraea sp.		f	+
Familia NATICIDAE			
Criptonatica sp.			++
** ***Eunaticina striatella*** (Grateloup, 1828)	Figs. 44-45		++
Lunatia helicina (Brocchi, 1814)			++

Tabla I. Continuación.
Table I. Continuation.

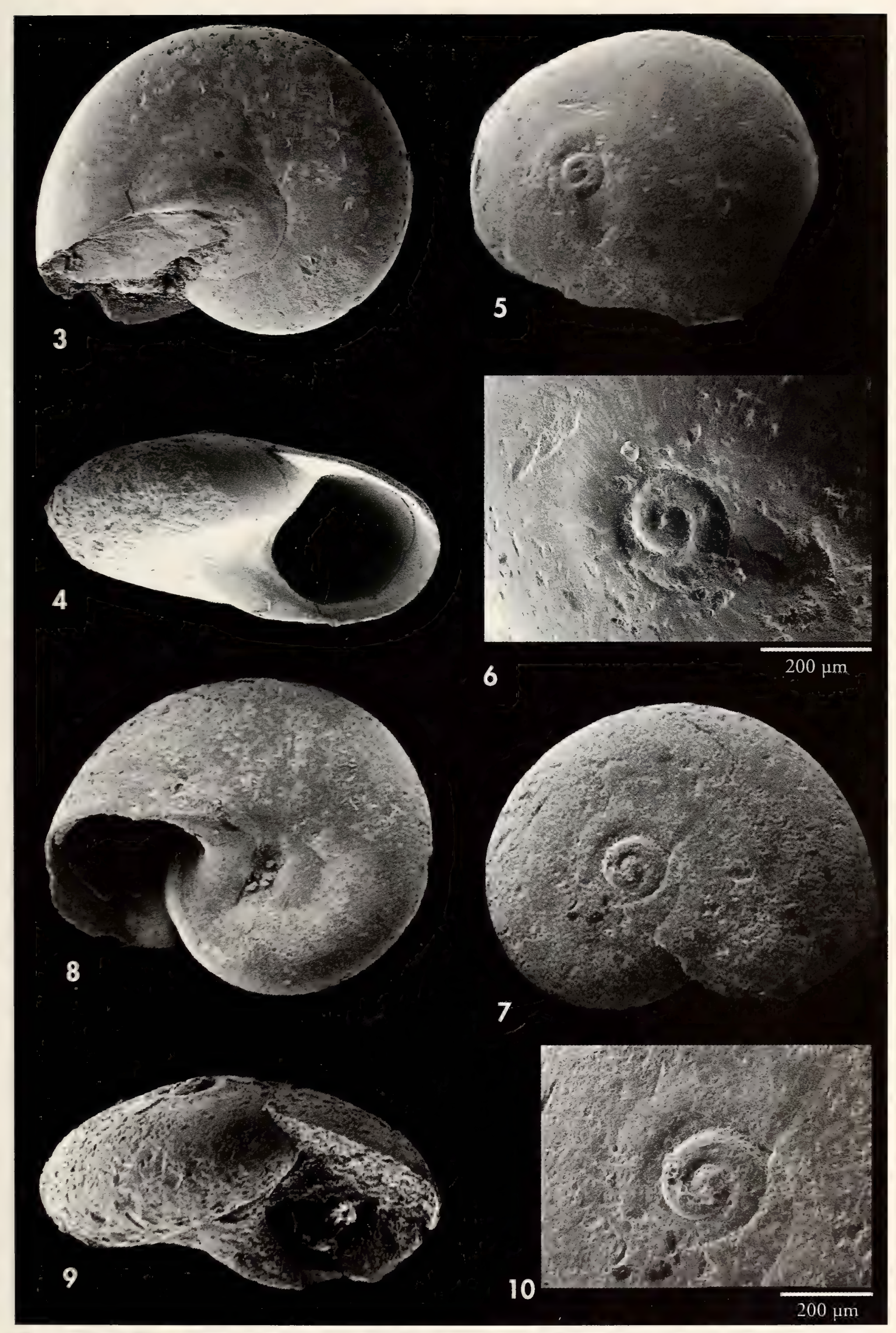
Species	Fig		Abundancia	
Natica millepunctata Lamarck, 1822			+++	
Neverita josephina Risso, 1826			+++	
** *Tectonatica miopusilla* (Kautsky, 1925)			+	B
Familia CASSIDAE				
Cassidaria sp.			+	
Familia BURSIDAE				
* *Bursa cancellata* (Gratelup, 1840)			+	
Familia MURICIDAE				
Murex aquitanicus (Grateloup, 1833)			++	
** *Murex aturensis* (Cossmann y Peyrot, 1923)			+	
Murex sp.		f	+	
* *Ocinebrina avitensis* (Cossmann y Peyrot, 1923)			+	
Ocinebrina sp.			+	
Hadriania craticulata boecki (Hörnes y Auinger, 1885)	Fig. 46		+++	
Purpura duvergieri (Cossmann y Peyrot, 1924)			++	
** *Purpura vindobonensis altispirata* Venzo y Pelosio, 1963		++		
* *Tritonalia polimorpha* (Brocchi, 1814)			++	
Familia BUCCINIDAE				
Melongena cornuta (Agassiz, 1843)			++	
Phos poligonus (Brocchi, 1814)	Fig. 47		+	
Familia FASCIOLARIIDAE				
Euthriofusus burdigaliensis (Defrance, 1820)			+	
Familia NASSARIIDAE				
Amyclina aff. *karreri* (Hörnes y Auinger, 1822)			++	
Nassarius* cf. *aturensis (Peyrot, 1928)	Figs. 48-49		+	
Nassarius girondicus (Peyrot, 1927)			++++	
** *Nassarius impar* (Bellardi, 1878)	Fig. 50		+	
Nassarius schoenni (Hörnes y Avuinger, 1882)	Figs. 51-52		+++	
Cyllene vulgatissima Peyrot, 1927			++++	
Familia COLUMBELLIDAE				
Pyrene fallax (Hörnes y Auinger, 1880)			+	
Familia OLIVIDAE				
Oliva sp.		f	+	
Familia VASIDAE				
* *Tudicla rusticula* (Basterot, 1825)		f	+	
Familia CANCELLARIIDAE				
Cancellaria sp.			+	
Narona varicosa (Brocchi, 1814)			+	
Narona dufoiri (Grateloup, 1832)		f	+	B
Trigonostoma scrobiculatum (Hörnes, 1856)	Figs. 53-55		+++	
Familia CONIDAE				
* *Conus dujardini* Deshayes, 1845			+	
Familia TEREBRIDAE				
Strioterebrum basteroti (Nyst, 1845)	Fig. 56		+++	
Subula fuscata (Brocchi, 1814)			+	
Terebra acuminata Borson, 1820			++	
Familia TURRIDAE				
** *Agathotoma hautensis* (Csepreghy-Meznerics, 1953)			+++	
Bela sp. 1			+	

Tabla I. Continuación.
Table I. Continuation.

Species	Fig		Abundancia	
Bela sp. 2			++	
Clavatula spinosa (Grateloup, 1832)	Figs. 57-60	f	++	
Clavatula jouanneti (Desmoulins, 1872)			+	
Gemmula denticula (Basterot, 1825)			+++	
Gemmula sp.			+	
Raphitoma cf. *hispidula* (Jan *in* Bellardi, 1847)			+	
Familia PYRAMIDELLIDAE				
Pyramidella unisulcata Dujardin, 1837	Fig. 61		+++	
** ***Chrysallida cimbrica*** (Kautsky, 1925)	Figs.62-66		++++	
Chrysallida sp.	Figs. 67-68		+	
* *Eulimella acicula* (Philippi, 1836)			+	
** ***Eulimella iusta*** nom. nov.			+	
*** ***Eulimella penedesensis*** spec. nov.	Figs. 69-73		+++	
* *Eulimella scillae* (Scacchi, 1835)			++	
Eulimella sp. 1	Fig. 74		+	
Eulimella sp. 2			+	
** ***Syrnola hoernesi*** (Koenen, 1882)	Figs. 75-77		++	
** ***Syrnola laevissima*** (Basquet, 1859)	Figs. 78-79		+++	
Syrnola sp.	Figs. 80		+	
* ***Megastomia pallidaeformis*** (Sacco, 1892)			++	
** ***Odostomia degrangei*** (Cossmann y Peyrot, 1917)	Figs. 81-82		++	
** ***Odostomia aff. desuefacta*** Peñas y Rolán, 1999	Fig. 83		+	
** ***Odostomia vera*** nom. nov.	Figs. 84-87		+++	
** ***Odostomia perstricta*** (Sacco, 1892)			+	
Odostomia polysarcula (Cossmann y Peyrot, 1917)			+	
* ***Odostomia turritella*** (Grateloup, 1832)	Figs. 88-92		++++	
Odostomia sp. 1			+	
Odostomia sp. 2	Fig. 93		+	
Ondina sp.			+	
*** ***Noemiamea batllorii*** spec. nov.	Figs. 94-96		++	
** ***Turbonilla pliomagna*** Sacco, 1892			+	B
** ***Turbonilla sallomacensis*** Cossmann y Peyrot, 1917	Fig. 97-98		++	
*** ***Turbonilla olivellai*** spec. nov.	Figs. 99-101		+++	
Turbonilla sp. 1			+	B
Turbonilla sp. 2	Fig. 102-103		+	
Familia EBALIDAE				
** ***Anisocycla cf. bezanconi*** Cossmann y Lambert, 1884	Figs. 104-107		++	
** ***Anisocycla eulimoides*** Fekih, 1969	Figs. 108-109		++	
Familia AMATHINIDAE				
* ***Clathrella sulcosa*** (Brocchi, 1814)		f	+	
Familia ACTEONIDAE				
* *Acteon semistriatus* (Basterot, 1825)			++	
Acteon sp.			+	
Familia RETUSIDAE				
** *Retusa obtusa* (Montagu, 1803)			++	
** *Retusa semisulcata* (Philippi, 1836)			+++	
Retusa truncatula (Bruguière, 1792)			+++	

Tabla I. Continuación.
Table I. Continuation.

Species	Fig		Abundancia	
Familia RINGICULIDAE				
* *Ringicula ventricosa* (Sowerby, 1824)			++	
Ringicula sp.		f	+	
Familia CYLICHNIDAE				
Acteocina lajonkaireana (Basterot, 1825)			++++	
Familia CAVOLINIDAE				
Vaginella austriaca Kittl, 1886			++	B
Familia ELLOBIIDAE				
Ovatella sp.			+	
Clase BIVALVIA				
Familia ARCIDAE				
(Lamarck, 1805)			+++	
Familia NOETIDAE				
Noetiella rollei (Hörnes, 1870)			+++	
Familia MYTILIDAE				
Mytilus cf. *michelini* Matheron, 1843			+++	
Familia PINNIDAE				
Atrina pectinata (Linné, 1767)			+++	
Familia ANOMIIDAE				
Anomia ephippium Linné, 1758			+++	
Familia OSTREIDAE				
Ostrea edulis Linné, 1758	Figs. 110-113		++	
Familia CHAMIDAE				
* *Chama gryphoides* Linné, 1758			+	
Familia CARDIIDAE				
Cardium cf. *hians* Brocchi, 1814		f	+	
* *Acanthocardia paucistriata* (G.B. Sowerby, 1841)			++	
Familia TELLINIDAE				
* *Gastrana lacunosa* (Chemnitz, 1782)			+	
Familia DONACIDAE				
Donax sp.			+	
Familia SEMELIDAE				
Ervilia cf. *pusilla* (Philippi, 1836)			+	
Familia KELLIELLIDAE				
** *Alveidus nitidus* (Reuss, 1867)	Figs. 114-120		++++	
Familia VENERIDAE				
Callista sp.			+	B
Venus sp.			++	
Pitar rudis (Poli, 1795)			++	
Tapes sp.			+	
Familia CORBULIDAE				
* *Corbula revoluta* (Brocchi, 1814)			+++	
* *Corbula gibba* (Olivi, 1792)			+++	
Clase SCAPHOPODA				
Familia DENTALIIDAE				
* *Antalis mutabilis* (Hörnes, 1856)			++	
* *Fustiaria jani* (Hörnes, 1856)			+++	
Familia GADILINIDAE				
* *Gadilina triquetra* (Brocchi, 1814)			+	



Figuras 3-6. *Teinostoma defrancei.* 3-5: conchas, 2,5, 2,0 y 1,7 mm; 6: protoconcha. Figuras 7-10. *Teinostoma minimum.* 7-9: conchas, 1,5,1,5 y 1,9 mm; 10: protoconcha.
Figures 3-6. Teinostoma defrancei. *3-5: shells, 2.5, 2.0 and 1.7 mm; 6: protoconch. Figures 7-10.* Teinostoma minimum. *7-9: shells, 1.5, 1.5 and 1.9 mm; 10: protoconch.*

Cerithiopsis minima (Brusina, 1865) (Figs. 17-19)

Cerithium minimum Brusina, 1865. *Verhandl. Zool. Bot. Gessell., Wien*, 15: 17.
Bittium reticulatum (Da Costa, 1778) in BATLLORI (1995). *Tesis Doct.* Univ. Barcelona, lám. 7, figs. 25.1-25.3.

Material examinado: 70 c.

Descripción: Concha (Figs. 17, 18) diminuta, pupoide; protoconcha (Fig. 19) lisa, subcilíndrica, de 4 vueltas; Escultura de la teloconcha formada por tres cordones espirales desde la primera vuelta, granulosos y un cordón basal espiral en ejemplares adultos. No hemos apreciado diferencias en las dimensiones, tanto de la concha como de la protoconcha, entre la especie fósil y la actualmente viviente, ni tampoco hemos observado diferencias en la relación H/D.

Dimensiones medias: 2,5 x 0,6 mm en 6 vueltas de la teloconcha.

Comentarios: No hemos encontrado cita de esta especie ni en el Mioceno ni en el Plioceno, y sí de *C. tubercularis* (Montagu, 1803) y de *C. nana* (Wood, 1848), especies parecidas. HARMER (1915) cita *C. minima* para el Crag británico, pero según MARQUET (1997), con el que estamos de acuerdo, la determinación es incorrecta ya que se trata de *C. nana*.

Obtusella orisparvi spec. nov. (Figs. 21-24)

Material tipo: Holotipo (Fig. 21) y un paratipo depositados en el MNCN (nºs MNCNI-37741 y 37742). Otros paratipos: MVV (3), MGSB (3) y MMP (3)
Otro material examinado: Más de 200 c.
Localidad tipo: Mioceno medio (Langhiense), La Pedrera, Sant Llorenç d'Hortons (Barcelona).
Etimología: El nombre específico deriva de las palabras latinas *os-oris*, boca, y *parvus-a-um*, pequeño, que hacen referencia a la pequeñez de la abertura de esta concha.

Descripción: Concha (Figs. 21, 22) diminuta, pero sólida, conoidea, algo pupoide. Ápice obtuso, con la protoconcha lisa (Fig. 24), dificil de definir su longitud por no presentar un claro límite con la teloconcha, pero presentando un cordón spiral próximo a la sutura. Espira total de la concha con unas 3,5-4 vueltas convexas. Sutura no profunda, impresa (Fig. 23). Hay indicios de algunas estrías espirales subsuturales y las líneas de crecimiento son ligeramente prosoclinas. Abertura circular, pequeña. Sin claro ombligo, pero en algunas conchas con una estrecha fisura umbilical. Labro externo delgado.

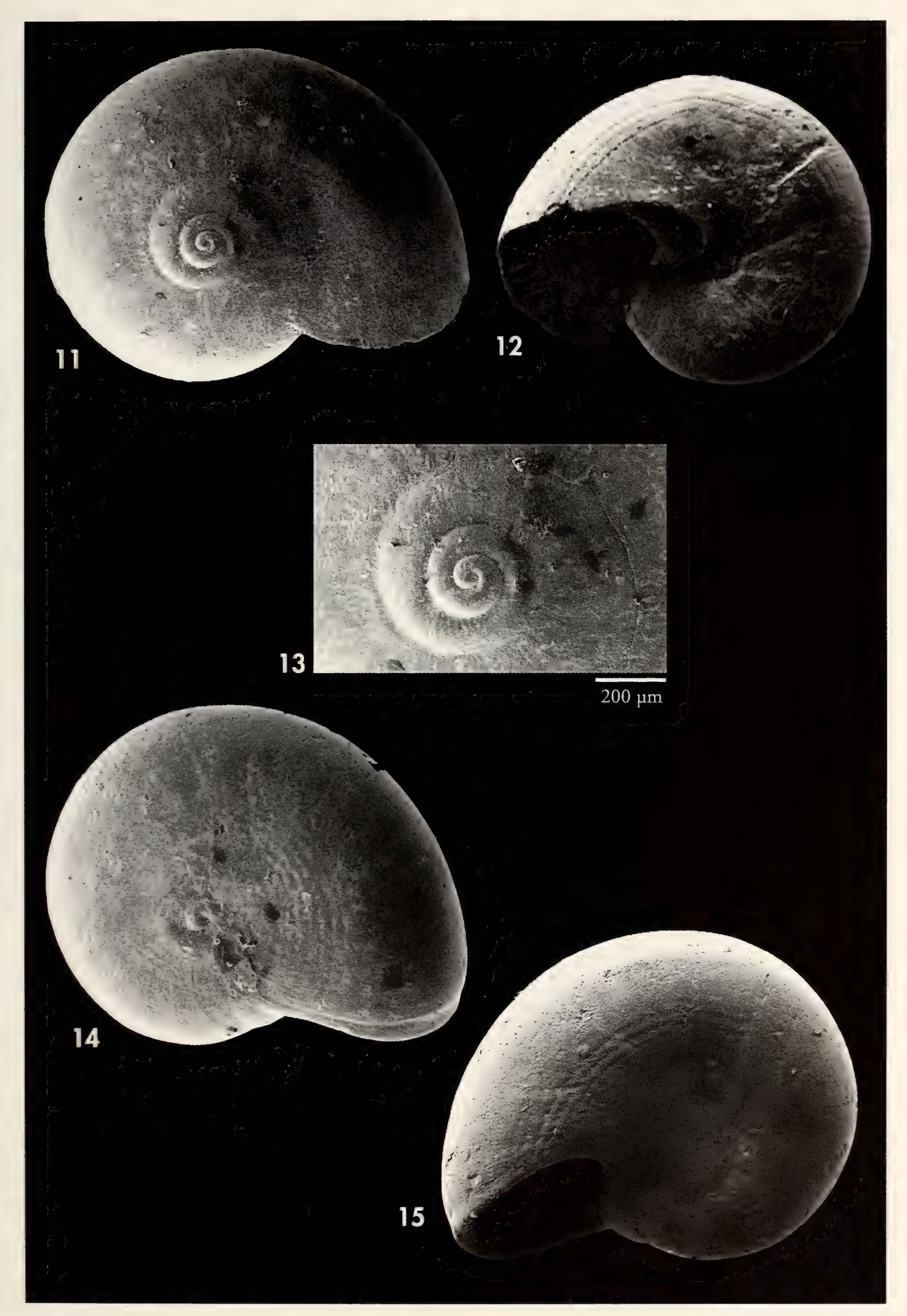
Dimensiones del holotipo: 0,96 x 0,56 mm en 4 vueltas.

Comentarios: Esta diminuta especie presenta claras diferencias con las dos especies de este género actualmente vivientes en el Mediterráneo y también con *O. sabelliana* Tabanelli, 1991 de la que hemos observado varios topotipos (col. Tabanelli). Esta especie vivió en aguas profundas del Plioceno inferior, asociada a *Korobkovia oblonga* y a *Limea strigillata* (Tabanelli *com. pers.*). Nuestra especie, que vivió en aguas someras tiene un perfil menos cónico, con la espira más elevada, las vueltas más convexas y la protoconcha es lisa, mientras que en *O. sabelliana* es esculturada.

O. macilenta (Monterosato, 1880), actual, que vive en aguas profundas del Mediterráneo, también tiene la protoconcha lisa, pero la concha tiene un perfil más cónico, con la última vuelta mucho más ancha, tiene la sutura profunda, la abertura mucho mayor y tiene un claro ombligo.

O. intersecta (S. W. Wood, 1857), del Plioceno y actual, tiene una concha mucho mayor, globosa, con clara escultura espiral y umbilicada.

O. lata Rolán y Rubio, 1999, actual, y que vive en el archipiélago de Cabo



Figuras 11-13. *Teinostoma woodi.* 11, 12: conchas, 2,1 y 1,5 mm; 13: protoconcha. Figuras 14, 15. *Teinostoma sp.* Concha, 1,0 mm, Can Rosell.
Figures 11-13. Teinostoma woodi. *11, 12: shells, 2.1 and 1.5 mm; 13: protoconch. Figures 14, 15.* Teinostoma *sp. Shell, 1.0 mm, Can Rosell.*

Verde, es más globosa y más cónica, mientras que *O. orisparvi* es mas alargada y con tendencia a la forma cilíndrica.

O. communis Boettger, 1906, del Tortoniense de Kostej, Hungría, también carece de escultura espiral, pero tiene una forma más cónica, casi piramidal, con la última vuelta más ancha; H/D = 1,5 frente a 1,7 en *O. orisparvi*; y la abertura es mayor: 45% H, frente al 35%. Ver en ZICH (1934: lám. 5, fig, 78) ilustración del holotipo.

Circulus striatus (Philippi, 1836)

Valvata striata Philippi, 1836. *En. Moll. Soc.*, 1: 147, lám. 9, figs. 3a-c.
Tornus planorbillus (Dujardin, 1837) in BATLLORI, 1995. *Tesis Doct.* Univ. Barcelona, lám. 3, fig. 7.

Material examinado: 3 c.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Cuenca del Loira, Francia (GLIBERT, 1952); Mioceno medio (Langhiense): La Pedrera, Barcelona. Mioceno superior: Tortoniense de Calabria, Italia (SEGUENZA, 1880). Plioceno: Kallo, Cuenca del Mar del Norte, Bélgica (MARQUET, 1997), Crag británico (WOOD, 1848); Plioceno piamontés, Italia (PAVIA, 1975); Tabiano modenense, Italia (COPPI, 1880); Estepona, Málaga (VERA-PELÁEZ *ET. AL.*, 1996). Actual: Mediterráneo y costa occidental de África (ADAM Y KNUDSEN, 1969).

Dimensiones: de 2,3 a 3,5 mm.

Comentarios: Las conchas encontradas en el yacimiento de La Pedrera no presentan diferencias apreciables con las actuales. Se trata de la primera cita para el yacimiento.

Elachisina moravica (Rzehak, 1893) (Figs. 25, 26)

Littorina moravica Rzehak, 1893. Fauna der Oncophora Schichten Maehrens: 30, lám. 2, figs. 2, 3.

Material examinado: 80 c.

Descripción: Concha (Fig. 25) muy pequeña naticiforme, con las vueltas convexas, de crecimiento muy rápido, la última vuelta globosa. Protoconcha (Fig. 26) obtusa, lisa. Escultura de la teloconcha formada por finas estrías espirales en toda la superficie, distribuidas de forma regular. Abertura grande, subcircular, con el peristoma continuo. Columela delgada, a veces replegada hacia la zona umbilical. Fisura umbilical estrecha pero profunda.

Dimensiones medias: 1,8 x 1,4 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio de Moravia, Rep. Checa (COSSMANN, 1921). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Esta es la primera cita para el Mioceno de la Península Ibérica.

Ver PONDER (1985), en el que describe la nueva familia Elachisinidae (Rissoacea).

Actualmente está en estudio la revisión de las *Elachisina* del África Occidental, las cuales podrían ser descendientes de esta especie miócenica, la única que conocemos.

Caecum verai spec. nov. (Figs. 27-30)

Material tipo: Holotipo (Fig. 27) y un paratipo, depositados en el MNCN (nºs MNCNI- 37743 y 37744). Otros paratipos: MVV (1), MGSB (2) y MMP (1).
Otro material examinado: 3 c.

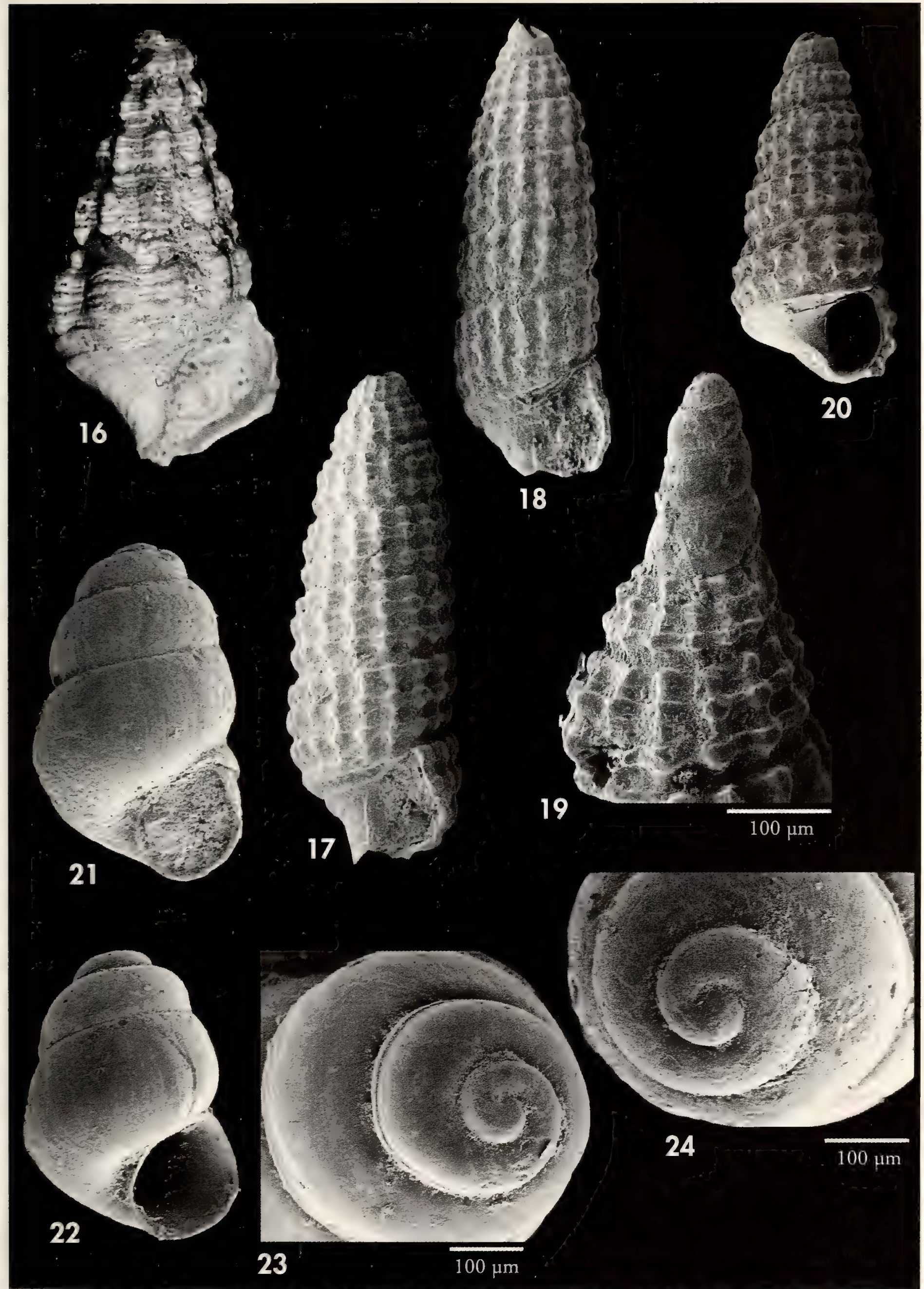


Figura 16. *Cerithium bronni.* Concha, 6,1 mm. Figuras 17-19. *Cerithiopsis minimum.* 17, 18: conchas, 2,5 y 2,2 mm; 19: protoconcha. Figura 20. *Cerithiopsis lottae.* Concha, 4,1 mm. Figuras 21-24. *Obtusella orisparvi.* 21: holotipo, 0,96 mm; 22: concha, 0,8 mm; 23: detalle de la sutura; 24: protoconcha.

- *Figure 16.* Cerithium bronni. *Shell, 6.1 mm. Figures 17-19.* Cerithiopsis minimum. 17, *18: shells, 2.5 and 2.2 mm; 19: protoconch. Figure 20.* Cerithiopsis lottae. *Shell, 4.1 mm. Figures 21-24.* Obtusella orisparvi. *21: holotype, 0.96 mm; 22: shell, 0.8 mm; 23: detail of the suture; 24: protoconch.*

Localidad tipo: Mioceno medio (Langhiense), La Pedrera, Sant Llorenç d'Hortons, (Barcelona).
Etimología: El nombre específico se dedica al Dr. José Luis Vera, del MMP, de Estepona, por su ayuda en la determinación de varias especies.

Descripción: Concha (Figs. 27, 28) diminuta, cilíndrica. Escultura anular (Fig. 29) conspicua formada por estrías y cordoncillos irregularmente distribuidos. Zona apical (Fig. 30) más atenuada, con el septum muy obtuso, suavemente arqueado en su parte anterior y ligeramente anguloso en la posterior. El perfil de la concha se va haciendo más estrecho en la zona de la apertura, la cual es circular, con el borde afilado.

Dimensiones del holotipo: 1,7 x 0,45 mm.

Discusión: Difiere de *C. banoni* Benoist, 1874, del Mioceno inferior (Aquitaniense) francés, que tiene unas dimensiones similares, pero con un perfil más anguloso; carece de escultura anular; la abertura sigue el perfil de la concha y en su borde interior tiene un delgado anillo; finalmente, tiene el septum prominente. Las ilustraciones de esta especie en LOZOUET, LESPEROT Y RENARD (2001) presentan un septum redondeado, mientras que en GLIBERT (1952a) es triangular.

C. subanulatum De Folin, 1870, viviente en el Mediterráneo y citada en el Plioceno, tiene unas dimensiones y un septum parecidos, pero carece de escultura anular y en la abertura tiene un anillo bien desarrollado. PORTA, MARTINELL Y GONZÁLEZ DELGADO (1993, lám. 3, fig. 4) muestran una concha procedente del Mioceno Langhiense de Sant Sebastiá dels Gorchs, Barcelona, que determinan como *C. subanulatum*, aunque nos parece más bien la especie que aquí describimos como *C. verai*.

C. glabrum (Montagu, 1803), viviente en el Atlántico europeo, citada por HARMER (1921) para el Crag británico y por GLIBERT (1952a) para el Mioceno medio de la Cuenca del Loira, tiene unas dimensiones mayores, carece de escultura anular, tiene la abertura menos atenuada y su septum es muy prominente.

CHIRLI (1995) en su revisión del género *Caecum* en el Plioceno Toscano describe e ilustra *C. crispum* Cerulli-Irelli, 1912 y *C. nysti* De Stefani y Pantanelli, 1878. Ambas especies tienen una concha mayor; además, la primera tiene un septum globoso, muy prominente y la segunda lo tiene triangular.

Discopsis belgicus (Glibert, 1949) (Figs. 34-36)

Adeorbis belgicus Glibert, 1949. *Mem. Inst. Roy. Sci. Nat. Belgique*, 121: 113, lám. 6, fig. 14.

Material examinado: 1 c.

Descripción: En GLIBERT (1949, 1952a) y en MARQUET (1997). En el presente trabajo se representa un ejemplar no adulto.

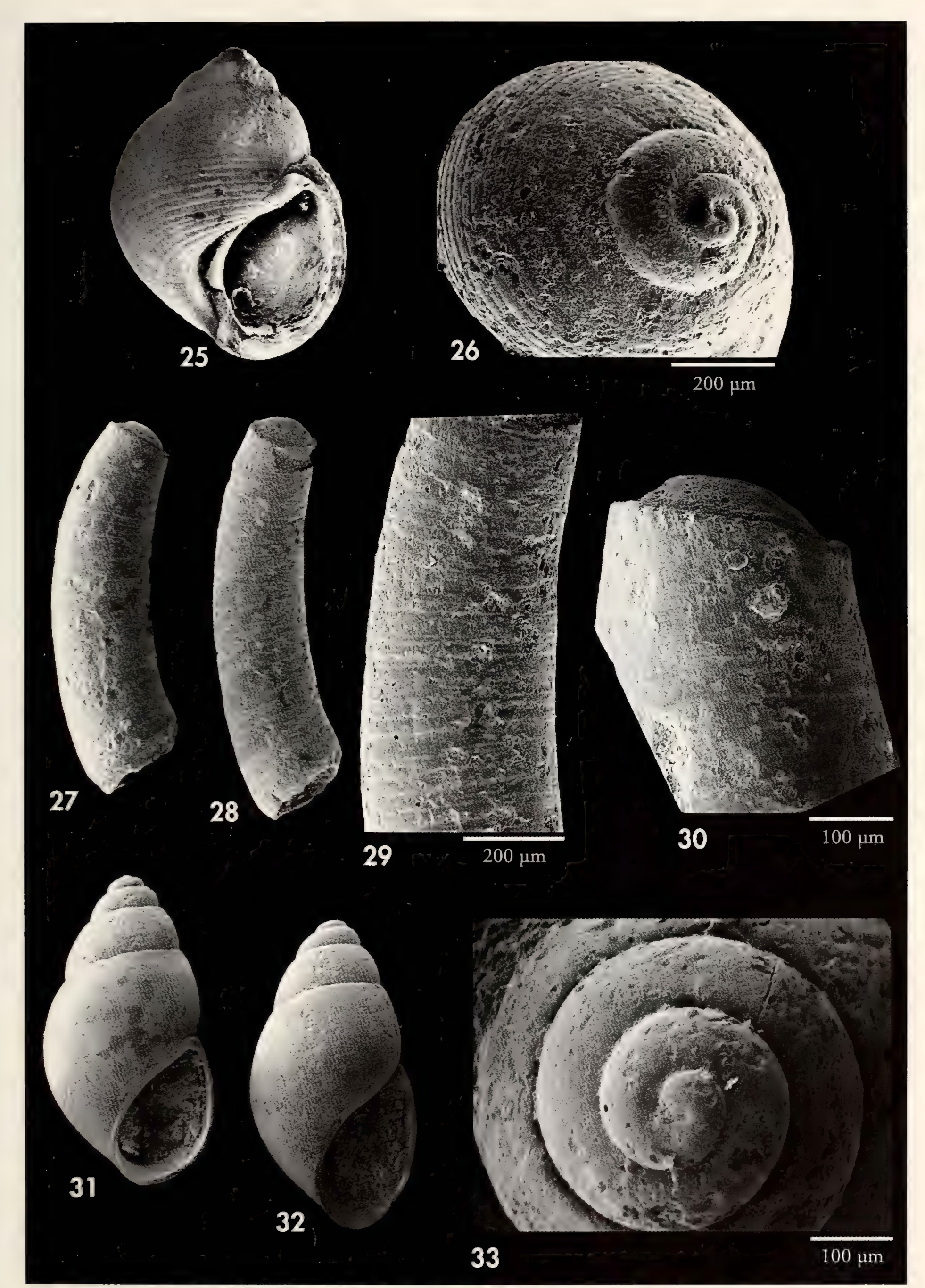
Dimensiones: 1,2 mm de diámetro.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Cuenca del Loira, Francia (GLIBERT, 1949); Mioceno medio (Langhiense): La Pedrera, Barcelona. Plioceno: Kallo, Cuenca del Mar del Norte, Bélgica (MARQUET, 1997).

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

De las tres especies encontradas en La Pedrera pertenecientes a este género, ésta se diferencia a primera vista por su espira saliente y sus dos carenas basales.

Las especies actuales de África Occidental que se habían incluido por ADAM Y KNUDSEN (1969) en el género *Cochliolepis* no parecen tener una real similitud en sus partes blandas con la especie tipo de este género del Caribe *Cochliolepis parasitica* Stimpson, 1859. En un reciente trabajo (ROLÁN Y RUBIO, 2002) este grupo de especies actuales, que morfológicamente se parecen a las fosiles aquí estudiadas, se han considerado en el género *Discopsis* De Folin, 1869 y por ese motivo utilizamos este género para la ubicación de las mismas



Figuras 25, 26. *Elachisina moravica.* 25: concha, 1,5 mm; 26: protoconcha. Figuras 27-30. *Caecum verai.* 27: holotipo, 1,7 mm; 28: concha; 29: detalle de la escultura anular; 30: septum. Figuras 31-33. *Hydrobia peregrina.* 31, 32: conchas, 1,8 y 1,9 mm; 33: protoconcha.

Figures 25, 26. Elachisina moravica. *25: shell, 1.5 mm; 26: protoconch. Figures 27-30.* Caecum verai. *27: holotype, 1.7 mm; 28: shell, 1.8 mm; 29: detail of the annular sculpture; 30: septum. Figures 31-33.* Hydrobia peregrina. *31, 32: shells, 1.8 and 1. 9 mm; 33: protoconch.*

Discopsis canui (Morgan, 1920) (Figs. 37-39)

Adeorbis woodi Ivolas y Peyrot, 1900: *Contr. Paléont. Tour.* (1900): 154 (*non* Hörnes).
Tornus canui Morgan, 1920. *Bull. Soc. Géol. France*, 19: 343, fig. 40.

Material examinado: 14 c.

Descripción: En MORGAN (1920) y en GLIBERT (1952a). Se ilustra la concha y la microescultura de la base.

Dimensiones medias: 1,1 mm de diámetro.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Faluns de la Touraine (MORGAN, 1920) y Cuenca del Loira, Francia (GLIBERT, 1952a). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Esta es la primera cita para el Mioceno de la Península Ibérica.

Esta especie se caracteriza por tener la espira más deprimida, ausencia de carena basal y tener la superficie muy tenuemente estriada.

Discopsis trigonostoma (Basterot, 1825) (Figs. 40-42)

Delphinula trigonostoma Basterot, 1825. *Mem. Soc. Hist. Nat. París*, 2: 28, lám. 4, fig. 10.

Material examinado: 36 c.

Descripción: En COSSMANN Y PEYROT (1918), GLIBERT (1952a) y JANSSEN (1984). En el presente trabajo se representa un ejemplar no adulto y la escultura de la base.

Dimensiones medias: 1,3 mm.

Distribución cronoestratigráfica y geográfica: Mioceno inferior: Aquitaniense de Saucats, Francia (LOZOUET *ET AL.* 2001); Burdigaliense de Léognan, Francia (BASTEROT, 1825 y COSSMANN Y PEYROT, 1918). Mioceno medio: Cuenca del Loira (GLIBERT, 1952); Winterswijk-Miste, Holanda (JANSSEN, 1984); Cuenca del Rhing, Kevelaer, Alemania (WIENRICH, 2001). Mioceno medio (Langhiense): La Pedrera, Barcelona. Mioceno superior: Tortoniense de Kostej, Hungría (BOETTGER, 1906).

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Eunaticina striatella (Grateloup, 1828) (Figs. 44, 45)

Natica striatella Grateloup, 1828. *Bull. Hist. Nat. Soc. Lin. Bordeaux*, 2: 158 nº 146.
Sinum sp. in BATLLORI (1995). *Tesis Doct.* Univ. Barcelona.

Material examinado: 3 c.

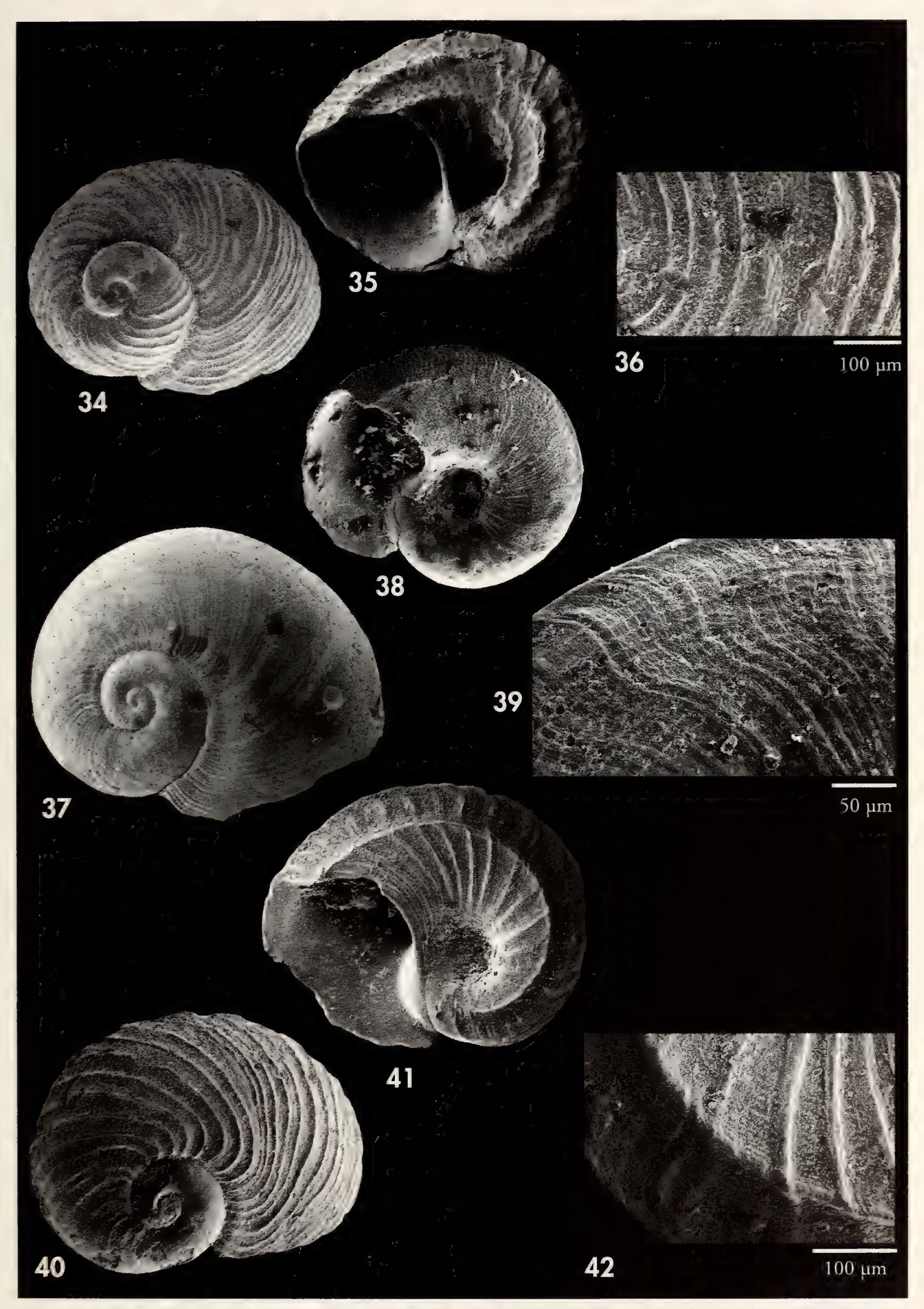
Descripción: En COSSMANN Y PEYROT (1919) y en JANSSEN (1984). En este trabajo se muestran concha y protoconcha.

Dimensiones medias: 9,8 mm.

Distribución cronoestratigráfica y geográfica: Mioceno inferior: Aquitaniense de Saucats y de las Landas y Burdigaliense de St-Jean-de-Marsacq (LOZOUET *ET AL.*, 2001). Mioceno medio: Winterswijk-Miste, Holanda (JANSSEN, 1984). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Creemos que es la única especie fósil de este género encontrada en Europa, la cual es muy cercana a *E. africana* Burnay y Fernandes, 1984, especie actual que vive en Angola y Gabón. Varias especies de este género, típico de aguas tropicales, viven también en el Indo-Pacífico.



Figuras 34-36. *Discopsis belgicus.* 34, 35: concha, 1,2 mm; 36: detalle de la escultura. Figuras 37-39. *Discopsis canui.* 37, 38: conchas, 1,3 y 1,0 mm; 39: detalle de la escultura basal. Figuras 40-42. *Discopsis trigonostoma.* 40, 41: conchas, 1,1 y 1,0 mm; 42: detalle de la escultura basal.
Figures 34-36. Discopsis belgicus. *34, 35: shell, 1.2 mm; 36: detail of the sculpture. Figures 37-39.* Discopsis canui. *37, 38: shells, 1.3 and 1.0 mm; 39: detail of the basal sculpture. Figures 40-42.* Discopsis trigonostoma. *40, 41: shells, 1.1 and 1.0 mm; 42: detail of the basal sculpture.*

Nassarius cf. *aturensis* (Peyrot, 1928) (Figs. 48, 49)

Nassa (Telasco?) aturensis Peyrot, 1928. *Act. Soc. Lin. Bordeaux*, 79 suppl.: 132, lám. 3, figs. 100-105.

Material examinado: más de 300 c.

Descripción: En PEYROT (1928) y en BATLLORI (1995). Concha (Fig. 48) pequeña, conoidea, robusta. Concha larvaria (Fig. 49) de 3 vueltas, planctotrófica, con un diámetro de unas 750 µm. Teloconcha de espira poco elevada, con unas 6 vueltas ligeramente convexas. Unas 16 costillas axiales robustas, redondeadas, ligeramente escalonadas, mucho más anchas que sus interespacios. Escultura espiral débil formada por estrechos surcos en los interespacios, más apreciable en la base de la última vuelta. Abertura subcircular, con el canal sifonal corto. Peristoma continuo. Labro externo varicoso en su exterior y en ejemplares adultos con seis dientes en su interior.

Dimensiones: se han medido 100 conchas presentando unas dimensiones medias de 3,45 x 1,75 mm. y unas dimensiones máximas de 5,75 x 2,25 mm; el ejemplar ilustrado mide 4,5 x 2,2 mm. La relación H/D media es de 1,97.

Distribución cronoestratigráfica y geográfica: Mioceno inferior: Aquitaniense, Francia (PEYROT, 1928). Mioceno medio (Langhiense): Alt Penedès, Barcelona (BATLLORI, 1995).

Comentarios: BATLLORI (1995) considera que no existen diferencias apreciables con la forma típica descrita por PEYROT (1928), salvo su menor tamaño, que atribuye a las condiciones paleoecológicas especiales de La Pedrera. En el material recolectado por nosotros, no sólo las diferencias de tamaño son muy considerables (8,5 x 3,5 mm en la especie aquitánica frente a 5,75 x 2,25 mm como máximo en la especie de La Pedrera), sino que las relaciones H/D son muy diferentes: > 2,4 en la especie aquitánica, frente a < 2 en la de La Pedrera. Por otra parte los ejemplares de La Pedrera tienen un perfil casi escalonado, y la escultura axial es siempre conspicua.

Nassarius schoenni (Hoernes y Auinger, 1882) (Figs. 51, 52)

Buccinum schönni Hoernes y Auinger, 1882. *Die Gasteropoden*.. 125, lám. 15, figs. 18-20.
Nassarius saccoi (Trentanove, 1911) in BATLLORI (1995). *Tesis Doct.* Univ. Barcelona: 347-350, lám. 18, figs. 59.1-59.3.

Material examinado: 40 c.

Descripción: En BALUK (1970 y 1997). Se ilustra aquí un ejemplar adulto (Figs. 51, 52).

Dimensiones: 10 x 6,7 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Cuenca de Viena, Austria (HÖRNES, 1856); Korytnika, Polonia (BALUK, 1997); Cuenca mediterránea austro-húngara (STRAUSZ, 1966); Mioceno medio (Langhiense): Depresión del Vallès ((VILLALTA Y ROSELL, 1966 y CALZADA *ET AL.*, 1972); La Pedrera, Barcelona; Colli turinés, Italia (BELLARDI, 1882). Mioceno superior: Tortoniense polaco (BALUK, 1970).

Comentarios: Los ejemplares de La Pedrera presentan un tamaño menor que los de la forma típica; también tienen la última vuelta más cuadrangular y la callosidad labial muy desarrollada en la zona adapical. Esta forma coincide con las ilustradas por BALUK (1970: lám. 12, fig. 13 y 1997: lám. 1, fig. 1) y también con la descrita como *N. dujardini* (Deshayes, 1844) por PEYROT (1928: 141, lám. 3, figs. 124-126).

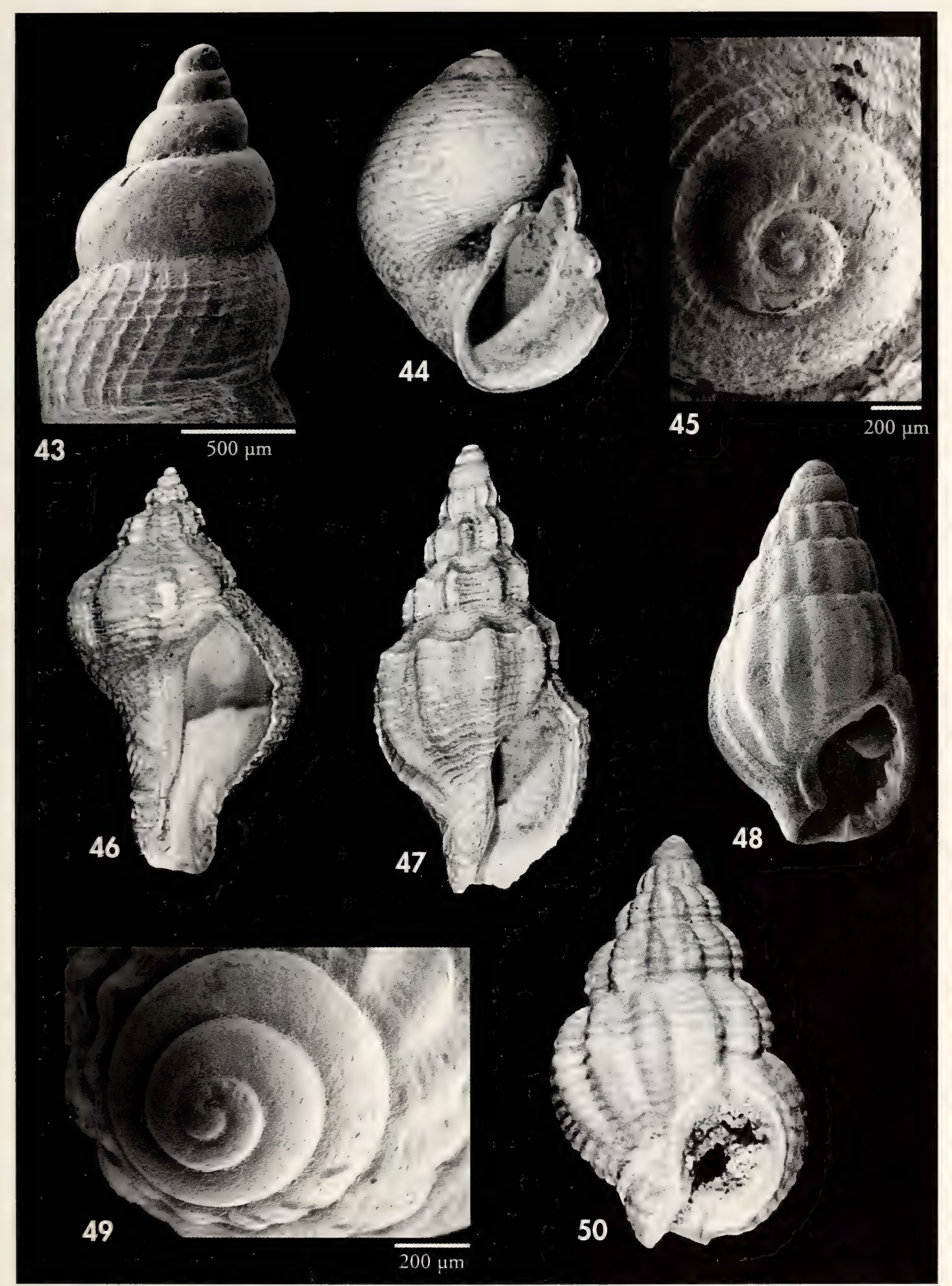


Figura 43. *Tibia dentata ordalensis*. Protoconcha. Figuras 44, 45. *Eunaticina striatella*. 44: concha, 9,8 mm; 45: protoconcha. Figura 46. *Hadriania craticulata boecki*. Concha, 15,2 mm. Figura 47. *Phos poligonus*. Concha, 11,1 mm. Figuras 48, 49. *Nassarius cf. aturensis*. 48: concha, 4,5 mm; 49: protoconcha. Figura 50. *Nassarius impar*. Concha, 6,0 mm.

Figure 43. Tibia dentata ordalensis. *Protoconch. Figures 44, 45.* Eunaticina striatella. *44: shell, 9.8 mm; 45: protoconch. Figure 46.* Hadriania craticulata boecki. *Shell, 15.2 mm. Figure 47.* Phos poligonus. *Shell, 11.1 mm. Figures 48, 49.* Nassarius cf. aturensis. *48: shell, 4.5 mm; 49: protoconch. Figure 50.* Nassarius impar. *Shell, 6.0 mm.*

Clavatula spinosa (Grateloup, 1832) (Figs. 57-60)

Pleurotoma spinosa Grateloup, 1832. *Actes Soc. Linn. Bordeaux*, 6e article: 5, 30: 324, lám. 19, fig. 24.

Material examinado: Varios fragmentos.

Distribución cronoestratigráfica y geográfica: Mioceno de Dax y Burdeos, Francia (GRATELOUP, 1832). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: BATLLORI (1995) describe *C. asperulata* (Lamarck, 1822) para el Mioceno del Penedès, especie muy citada durante el Mioceno en diferentes cuencas europeas, la cual se caracteriza por el desarrollo de espinas desde las vueltas juveniles. Por el contrario, en los ejemplares de La Pedrera y también en los del yacimiento cercano de Can Rosell no ocurre así. Según VERA (*com. per.*) nuestros ejemplares pertenecen a la especie *C. spinosa*, la cual se caracteriza por presentar una doble carena muy pronunciada.

Las conchas fotografiadas (Figs. 57-59) pertenecen al yacimiento cercano de Can Rosell, Subirats, Barcelona, donde esta especie es abundante. La protoconcha (Fig. 60) es lisa con 2,5 vueltas de espira.

Chrysallida cimbrica (Kautsky, 1925) (Figs. 62-66)

Pyrgulina cimbrica Kautsky, 1925. *D. Mioc. v. Hemmoor u. Busbeck-Osten*, 73: lám. 6, figs. 27, 28.

Material examinado: Más de 500 c.

Descripción: Concha muy pequeña (Figs. 62-65), algo cónica. Protoconcha (Fig. 66) obtusa, del tipo C, con un diámetro de unas 270 µm. Escultura axial de la teloconcha formada por entre 20 y 30 costillas, delgadas, flexuosas, algo más anchas que sus interespacios. Escultura espiral formada por 1-2 cordones en las vueltas anteriores y 2-3 en la última, muy juntos y situados justo sobre la sutura. Abertura oval, con un pliegue columelar débil y atrasado.

Dimensiones medias: 1,8 x 0,7 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Cuenca del Mar del Norte alemán y formación Arnum de Dinamarca (SORGENFREI, 1958). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

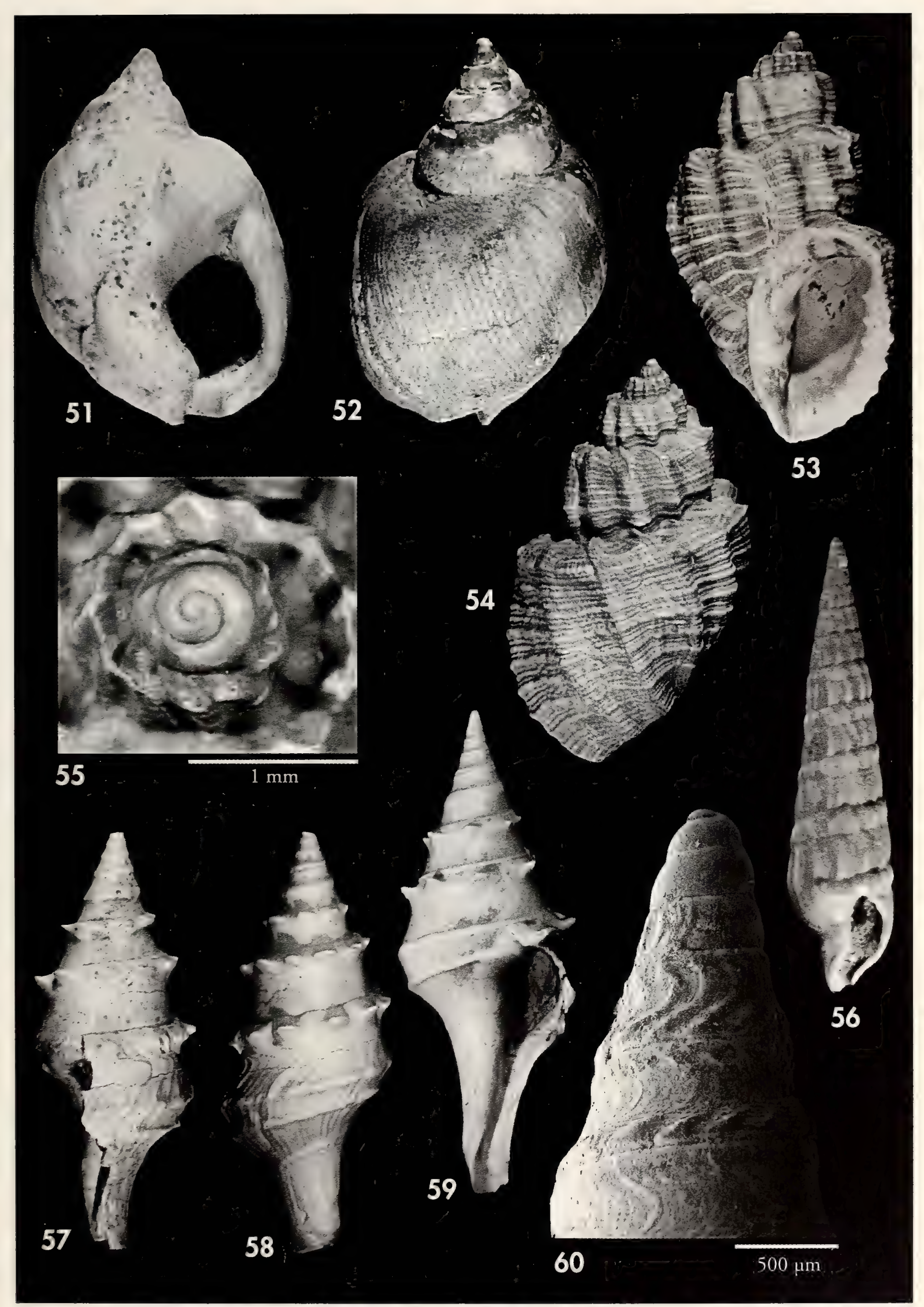
El gran número de ejemplares estudiados nos ha permitido observar que se trata de una especie muy variable, tanto en el perfil de las vueltas, como en la mayor o menor flexuosidad de las mismas, o la más o menos conspicua escultura espiral, a veces obsoleta. La forma extrema sería la ilustrada en las Figuras 64 y 65, más cercana a *C. longula* (Boettger, 1906 *sensu* Cossmann, 1921).

Chrysallida sp. (Figs. 67, 68)

Material examinado: 2 c.

Descripción: Concha (Figs. 67, 68) muy pequeña, subcilíndrica. Protoconcha obtusa, del tipo C. Teloconcha con unas 5 vueltas ligeramente convexas. Sutura profunda. Escultura axial formada por unas 18 costillas muy flexuosas, de igual anchura que sus interespacios; unas y otros se interrumpen brúscamente en la periferia de la última vuelta. Sin escultura espiral. Abertura oval, con un débil pliegue columelar.

Dimensiones: 2,4 x 0,7 mm.



Figuras 51, 52. *Nassarius schoenni.* Conchas. Figuras 53-55. *Trigonostoma scrobiculatum.* 53, 54: conchas, 22,7 mm; 55: protoconcha. Figura 56. *Strioterebrum basteroi.* Concha, 11,9 mm. Figuras 57-60. *Clavatula spinosa.* 57-59: conchas, 24,4 y 25,0 mm, Can Rosell; 60: protoconcha.
Figures 51-52. Nassarius schoenni. *Shells. Figures 53-55.* Trigonostoma scrobiculatum. *53, 54: shells,* 22.7 mm; *55: protoconch. Figure 56.* Strioterebrum basteroi. *Shell, 11.9 mm. Figures 57-60:* Clavatula spinosa. *57-59: shells, 24.4 and 25.0 mm, Can Rosell; 60: protoconch.*

Comentarios: Esta especie tiene un gran parecido con la pliocénica y actual *C. sigmoidea* (Monterosato, 1880), pero ésta última es mayor, tiene estrías espirales y carece de pliegue columelar.

Chemnitzia curvicostata S. Wood, 1848, descrita para el Crag británico, es muy parecida pero tiene un perfil más cónico y carece de pliegue columelar así como de escultura espiral, aunque WOOD (1848) reconoce que su material es de mala calidad. PAVIA (1976), que la cita para el Plioceno italiano de Monteu Roero, la describe con finísimas estrías espirales.

Eulimella iusta nom. nov.

Eulimella concinna Sorgenfrei, 1958 (non *Odostomia praelonga concinna* Jeffreys, 1884). *Geol. Surv. Denmark,* II, 79: 321, lám. 69, figs. 238a, b; lám. 70, fig. 238.

Material examinado: 1 c no adulta.
Etimología: El nombre especifico proviene de la palabra latina *iustus*, que significa justo, legítimo.

Descripción: En SORGENFREI (1958).

La protoconcha de *Eulimella iusta* es muy característica: del tipo B, planispiral, relativamente grande, que sobresale del perfil de la primera vuelta de teloconcha. Este tipo de protoconcha es común en varias especies que viven en aguas cálidas del África Occidental, pero no se encuentra en especies actuales del Mediterráneo y Atlántico europeo.

Dimensiones: 2 x 0,6 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Cuenca del Mar del Norte danés, formación Arnum (SORGENFREI, 1958). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Esta es la primera cita para el Mioceno de la Península Ibérica.

En la descripción de *Odostomia praelonga,* JEFFREYS (1884: 350) menciona que esta especie podría ser incluida en el género *Eulimella* y previamente dentro de esta descripción comenta lo siguiente: "*From the Adventure Bank Station I have an imperfect specimen and some fragments of apparently another species allied to the present. It was a thick shell with an angular periphery and a straight pillar, a slighter suture, and a smaller tooth. If more specimens should be found this may be named concinna.*" WARÉN (1980) refiere este taxon como *O. praelonga* var. *concinna,* aunque en la descripción de Jeffreys se hace referencia a una especie y no a una variedad; además, menciona sus caracteres diferenciales de una forma clara por lo que puede ser considerada una descripción válida, aunque limitada a un único ejemplar. Posteriormente, el nombre *Eulimella praelonga* se considera nombre no válido por estar ocupado por *Odostomia praelonga* Deshayes, 1861, y por tanto *Eulimella cerullii* (Cossmann, 1915) sería el nombre válido para la especie. Pero el nombre *concinna*, descrito antes de 1961 y sin que su autor le diese expresamente categoría infrasubespecífica, debe ser considerado válido incluso aunque el material tipo no haya aparecido, siendo además evidente que se trata de una *Eulimella*. NORDSIECK (1972) menciona el taxon *Eulimella concinna* como sinónimo de *E. pyramidata* (Deshayes, 1864) y SABELLI, GIANUZZI-SAVELLI Y BEDULLI (1990) como sinónimo de *E. praelonga*. Por todas las mencionadas razones, el nombre de *Eulimella concinna* debe considerarse utilizado y *E. concinna* Sorgenfrei, 1958 debe ser reemplazado.

Eulimella penedesensis spec. nov. (Figs. 69-73)

Material tipo: Holotipo (Fig. 69) y 3 paratipos depositados en el MNCN (nº MNCNI- 37745, y 37746-48). Otros paratipos: MGSB (3), MVV (3) y MMP (3).



Figura 61. *Pyramidella unisulcata.* Concha, 3,1 mm. Figuras 62-66. *Chrysallida cimbrica.* 62-65: conchas, 2,1, 1,8, 1,7 y 1,5 mm; 66: protoconcha. Figuras 67, 68. *Chrysallida* sp. Conchas, 2,4 y 1,5 mm.

Figure 61. Pyramidella unisulcata. *Shell, 3.1 mm. Figures 62-66.* Chrysallida cimbrica. *62-65: shells, 2.1, 1.8, 1.7 and 1.5 mm; 66: protoconch. Figures 67, 68.* Chrysallida *sp. Shells, 2.4 and 1.5 mm.*

Otro material examinado: 40 c.
Localidad tipo: Mioceno medio (Langhiense), La Pedrera, Sant Llorenç d'Hortons (Barcelona).
Etimología: El nombre específico hace referencia a la comarca, El Alt Penedès, donde está ubicado este yacimiento.

Descripción: Concha (Figs. 69-71) muy pequeña pero sólida, subcilíndrica. Protoconcha (Figs. 72, 73) del tipo A-II, pequeña, bastante obtusa pero con la espira de 1,5 vueltas casi totalmente emergida, con un diámetro de 200 µm. Espira de la teloconcha no muy elevada, con 5-6 vueltas algo convexas, la última oval redondeada, h = 50% H. Relación H/D = 3. Sin otra escultura que la formada por las líneas de crecimiento (Figs. 72, 73), que es bien conspicua y característica: a partir de la sutura inferior las líneas de crecimiento son muy arqueadas y opistoclinas hasta un tercio antes de la sutura superior, donde pasan a ser muy prosoclinas, también arqueadas; el cambio de dirección de las líneas de crecimiento forma una especie de cinturón, visible en la mayoría de ejemplares. Abertura oval-piriforme. Columela arqueada, opistoclina, replegada sobre sí misma. Sin diente ni pliegue columelar.

Dimensiones del holotipo: 2,6 x 0,9 mm en 6 vueltas de teloconcha.

Discusión: Esta especie tiene un cierto parecido con *Eulimella (Liostomia) hydrobiopsis* Cossmann y Peyrot, 1917 del Mioceno inferior (Aquitaniense) francés, sin embargo esta especie tiene la superficie lisa, incluso a gran aumento, mientras que en *E. penedesensis* se observa a simple vista la curiosa escultura, salvo en ejemplares muy deteriorados; pero incluso en ellos se puede apreciar una especie de cinturón o banda oscura que separa las líneas de crecimiento de muy opistoclinas a muy prosoclinas.

No conocemos ninguna especie fósil o actual, de los mares europeos y oesteafricanos, con esa escultura tan característica.

Eulimella sp. 1 (Fig. 74)

Material examinado: 1 c.

Descripción: Concha muy pequeña, cónica regular. Protoconcha del tipo A-II, con el núcleo emergido y con un diámetro de unas 280 µm. Teloconcha de espira elevada, con 5 vueltas planas, de crecimiento lento en altura, la última muy angulosa en la periferia. Sutura somera, pero bien marcada. Abertura pequeña, romboide. Profundamente umbilicada.

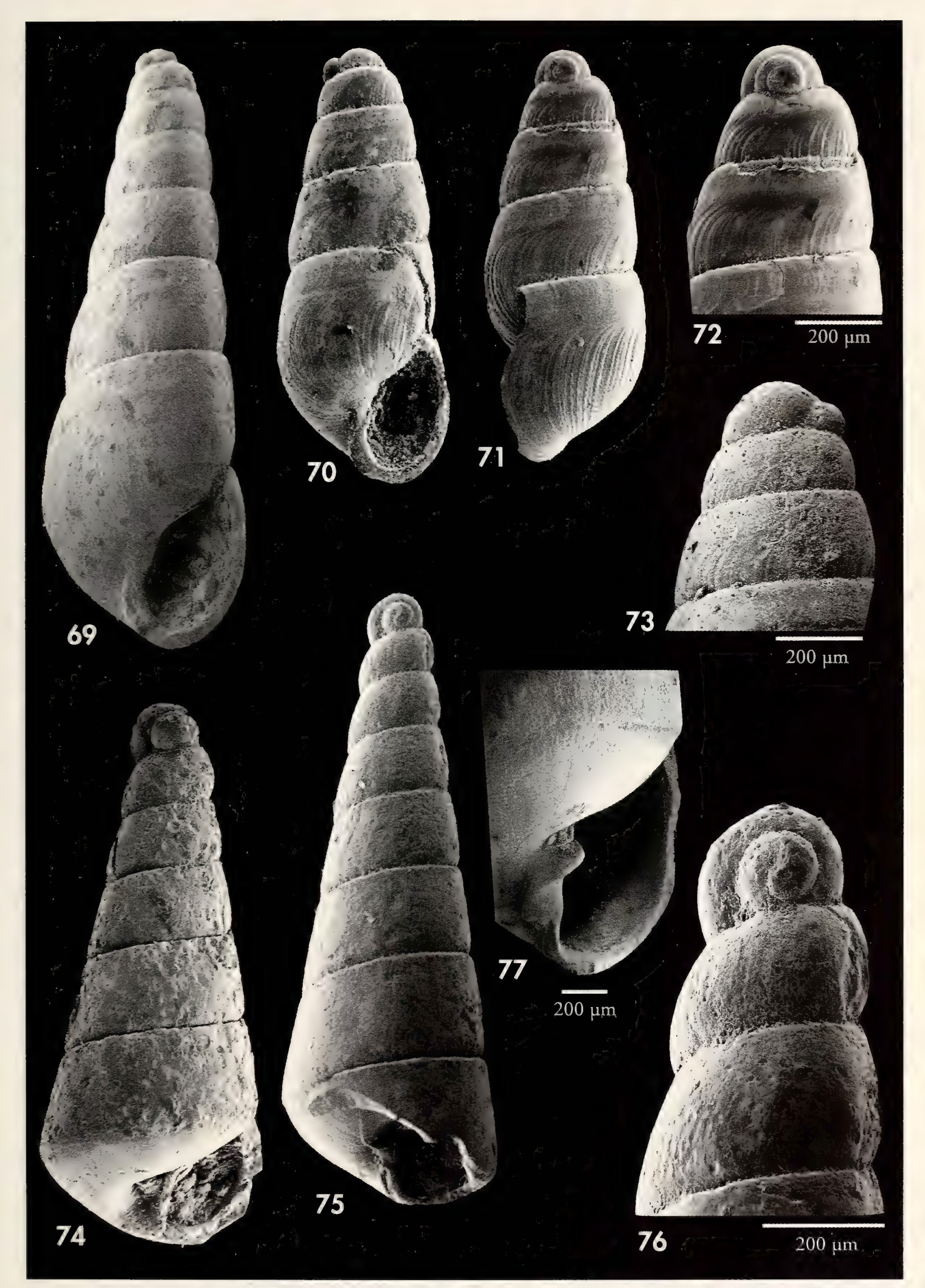
Dimensiones: 2,1 x 0,9 mm.

Comentarios: Se trata de una concha muy parecida a *S. hoernesi* (ver Figs. 75-77) de la que se diferencia por tener un claro y profundo ombligo; y carecer aparentemente de pliegue columelar.

Eulimella sp. 2

Material examinado: 1 c, juvenil.

Comentarios: El ejemplar encontrado, bastante deteriorado, es un juvenil formado por la protoconcha y una sola vuelta de teloconcha, insuficiente para su descripción; sin embargo la protoconcha se asemeja en su forma y dimensiones a la de *E. unifasciata* (Forbes, 1844) viviente en el Mediterráneo y Atlántico.



Figuras 69-73. *Eulimella penedesensis*. 69: holotipo, 2,6 mm; 70, 71: conchas, 1,6 y 1,4 mm; 72, 73: protoconchas y detalle de la escultura. Figura 74. *Eulimella sp.* Concha, 2,1 mm. Figuras 75-77. *Syrnola hoernesi*. 75: concha, 2,8 mm; 76: protoconcha; 77: detalle de la columela.
Figures 69-73. Eulimella penedesensis. *69: holotype, 2.6 mm; 70, 71: shells, 1.6 and 1.4 mm; 72, 73: protoconchs and detail of the sculpture. Figure 74.* Eulimella *sp. Shell, 2.1 mm. Figures 75-77.* Syrnola hoernesi. *75: shell, 2.8 mm; 76: protoconch; 77: detail of the columella.*

Syrnola hoernesi (Koenen, 1882) (Figs. 75-77)

Turbonilla hoernesi Koenen, 1882. *Abhan. Geol. Spec.* Preussen Thuringischen Staaten, 2: 263, lám. 6, fig. 1.

Material examinado: 10 c.

Descripción: En GLIBERT (1949, 1952b), ANDERSON (1964), NORDSIECK (1972) y JANSSEN (1972, 1984).

Concha (Fig. 75) cónica, pequeña. Protoconcha (Fig. 76) del tipo A-II, con un diámetro de 250 µm. Espira elevada. Sutura estrecha, pero muy profunda. Líneas de crecimiento ortoclinas. Abertura con un fuerte pliegue columelar (Fig. 77).

Dimensiones: 2,8 x 0,8 mm en 6 vueltas de la teloconcha.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Helveciense de la Cuenca del Loira, Francia y Anversiense belga (GLIBERT, 1949, 1952); Cuenca del Norte y Oeste alemán (ANSERSON, 1964); Winterswijk-Miste, Holanda (NORDSIECK, 1972 y JANSSEN, 1984). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

GLIBERT (1952b) compara esta especie con *E. neumayeri* (Koenen, 1882), de la que se distingue por su mayor tamaño, vueltas más numerosas, elevadas y bien planas, su perfil más regularmente cónico y estrecho.

Ver comentarios en *Eulimella* sp. 1.

Syrnola laevissima (Bosquet, 1859) (Figs. 78, 79)

Turbonilla laevissima Bosquet, 1859. *Natuurk. Verh. Akad. Amsterdam*, 7: 18, lám. 2, figs. 5a-c.

Material examinado: Más de 150 c.

Descripción: En JANSSEN (1963) y R. JANSSEN (1979).

Concha (Fig. 78) alargada, pupoide, muy pequeña. Protoconcha (Fig. 79) del tipo A-II, con un diámetro de 220 µm, con el núcleo semisumergido. Teloconcha de espira poco elevada, las vueltas casi planas, la última oval alargada, aproximadamente la mitad de la altura total de la concha. Sutura somera, muy inclinada. Líneas de crecimiento ortoclinas. Abertura pequeña, romboide, con el peristoma continuo en ejemplares adultos. Columela opistoclina, con un diente columelar oblicuo, bien conspicuo y adelantado.

Dimensiones medias: 2,7 x 0,75 mm en 5 vueltas de la teloconcha.

Distribución cronoestratigráfica y geográfica: Oligoceno de Belgica, Holanda y Alemania. Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Ver comentarios en *Syrnola* sp.

Syrnola sp. (Fig. 80)

Material examinado: 6 c.

Descripción: Concha cónica, estrecha, alargada. Protoconcha del tipo A-II, con una vuelta del núcleo emergida en su totalidad. Teloconcha con las vueltas plano-cóncavas. Sutura estrecha, somera, muy inclinada. Abertura pequeña, estrecha. Columela replegada sobre sí misma, con un diente columelar muy oblícuo.



Figuras 78, 79. *Syrnola laevissima.* 78: concha, 2,5 mm; 79: protoconcha. Figura 80. *Syrnola sp.* Concha, 2,8 mm. Figuras 81, 82. *Odostomia degrangei.* 81: concha, 2,3 mm; 82: protoconcha. Figura 83. *Odostomia* aff. *desuefacta.* Concha, 1,4 mm. Figuras 84-87. *Odostomia vera.* Conchas, 1,0, 1,3, 1,0 y 1,3 mm..

Figures 78, 79. Syrnola laevissima. *78: shell, 2.5 mm; 79: protoconch. Figure 80.* Syrnola *sp. Shell,* 2.8 mm. *Figures 81, 82.* Odostomia degrangei. *81: shell, 2.3 mm; 82: protoconch. Figure 83.* Odostomia *aff.* desuefacta. *Shell, 1.4 mm. Figures 84-87.* Odostomia vera. *Shells, 1.0, 1.3, 1.0 and 1.3 mm.*

Dimensiones: 2,8 x 0,7 mm en 6 vueltas de la teloconcha.

Comentarios: JANSSEN (1984: 356, lám. 16, figs. 3a-c) describe una *Syrnola* sp. de similares características.

Especie parecida a *S. laevissima*, pero la espira de *Syrnola* sp. es más elevada, el perfil más cónico, las vueltas son plano-cóncavas y la protoconcha es mayor y con la espira emergida.

Megastomia pallidaeformis (Sacco, 1892)

Odontostomia pallidaeformis Sacco, 1892. *I. Moll. ter. terz. Piem. e Lig.*, 11: 35, lám. 1, fig. 70bis.

Material examinado: 7 c.

Descripción: En Sacco (1892) y en COSSMANN Y PEYROT (1917). Representación del holotipo en FERRERO MORTARA *ET AL*. (1984, lám. 10, fig. 7).

Dimensiones medias: 2,7 x 1,2 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Colli turinés, Italia (SACCO, 1892); Helveciense de Sallespisse, Saucats y Orthez, Francia (COSSMANN Y PEYROT, 1917); Cuenca del Loira, Francia (GLIBERT, 1952); Winterswijk-Miste, Holanda (NORDSIECK, 1972). Mioceno medio (Langhiense): La Pedrera, Barcelona. Mioceno superior: Tortoniense de Cacella, Portugal (PEREIRA DA COSTA, 1866).

Comentarios: Ésta es la primera cita para el Mioceno medio de la Península Ibérica.

JANSSEN (1972) considera que la descripción e ilustración de SORGENFREI (1958) no corresponde a esta especie sino que se trata de *O.* aff. *mutinensis* (Sacco, 1892).

Odostomia degrangei (Cossmann y Peyrot, 1917) (Figs. 81, 82)

Odontostomia (Auristomia) degrangei Cossmann y Peyrot, 1917. *Conch. Néog. de l'Aquitaine:* 330, lám. 10, figs. 50, 51.

Material examinado: 8 c.

Descripción: En COSSMANN Y PEYROT (1917).

Concha (Fig. 81) muy pequeña, oval cónica. Protoconcha (Fig. 82) del tipo B, en forma de casquete, con un diámetro de 220 µm. Espira de la teloconcha corta, h = 70% H, con las vueltas convexas, la última grande, oval-redondeada. Sutura profunda. Superficie sin escultura, salvo las líneas de crecimiento que son ortoclinas a ligeramente prosoclinas. Abertura grande, oval. Columela arqueada, opistoclina, algo replegada sobre sí misma. Sin diente ni pliegue columelar visibles. No umbilicada.

Dimensiones: 2,5 x 1mm.

Distribución cronoestratigráfica y geográfica: Mioceno inferior: Burdigaliense y Mioceno medio: Orthez, Francia (COSSMANN Y PEYROT, 1917). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Odostomia aff. *desuefacta* Peñas y Rolán, 1999 (Fig. 83)

Odostomia desuefacta Peñas y Rolán, 1999. *Iberus*, suplemento 5: 52-54, figs. 117-119.

Material examinado: 1 c.

Descripción: Concha diminuta, cónica escalonada. Protoconcha más bien obtusa, del tipo A-II, con un diámetro de unas 200 µm, con la espira de 1,0 vueltas sumergida más de la mitad. Teloconcha con la espira muy corta, h > 65% H, con unas 3 vueltas convexas bajo la sutura y planas sobre ella, escalonadas. Sutura estrecha pero profunda, con un estrecho hombro bajo ella. Abertura pequeña, oval, estrecha. Peristoma continuo. Columela opistoclina, con pliegue columelar conspicuo, muy oblicuo.

Dimensiones: 1,0 x 0,5 mm.

Comentarios: Esta especie tiene un gran parecido con *O. desuefacta* Peñas y Rolán, 1999, que vive en aguas del África Occidental, en su forma escalonada, tipo de protoconcha, peristoma continuo y pliegue columelar oblicuo. Sin embargo, *O. desuefacta* es más alargada, H/D = 3, frente a 2,1 en la especie fósil; las vueltas crecen más deprisa, la repisa subsutural es angulosa y la abertura es mayor.

O. semperi (Bosquet, 1859), del Oligoceno holandés, también tiene las vueltas escalonadas, pero su perfil es más cónico, sus vueltas crecen más deprisa en anchura, el ápice es más agudo, la abertura mayor y el diente columelar es perpendicular a la columela. Ver ilustración de esta especie en JANSSEN (1963).

Odostomia vera nom. nov. (Figs. 84-87)

Chrysallida modesta Sorgenfrei, 1958. *Geol. Surv. Denmark*, II, 79: 309, lám. 67, figs. 228a, b. (non *Odostomia modesta* Stimpson, 1851).

Material examinado: 10 c.
Etimologia: El nombre especifico proviene de la palabra latina *verus* que significa verdadero.

Descripción: En SORGENFREI (1958).

Concha (Figs.84-87) minúscula, subcilíndrica. Protoconcha obtusa, del tipo C. Unas 4 vueltas de teloconcha convexas, la última oval redondeada. Escultura axial obsoleta formada por las líneas de crecimiento que son flexuosas. Escultura espiral formada por finísimas estrías en toda la vuelta entre suturas. Abertura oval. Sin diente columelar, sólo se observa un muy débil pliegue columelar.

Dimensiones medias: 0,8 x 0,3 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Cuenca del Mar del norte danés, formación Arnum (SORGENFREI, 1958). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Creemos que esta especie, descrita como *Chrysallida modesta* Sorgenfrei, 1958, debe ubicarse en el género *Odostomia*, ya que carece de escultura axial conspicua. La fina escultura espiral es común en muchas especies de este género. Por tanto, al ser encuadrada en el género *Odostomia* se produce una sinonímia con *Odostomia modesta* Stimpson, 1851, especie actual del Atlántico americano. Por ese motivo el nombre está ocupado y debe ser ser reemplazado.

El ejemplar de la figura 84 presenta un tamaño algo mayor, y las estrías espirales son más conspicuas y espaciadas; sin embargo, al no haber encontrado más material para comparar, creemos que esas diferencias pueden formar parte del rango de variabilidad.

Odostomia perstricta (Sacco, 1892)

Odontostomia (Macrodostomia) perstricta Sacco, 1892. *I Moll. ter. terz. Piemonte e Liguria*, 11: 44, lám. 1, fig. 98bis.

Material examinado: 1 c.

Descripción: FERRERO MORTARA *ET AL.* (1984: lám. 9, figs. 10a, b) ilustran el holotipo de esta especie.

Concha pequeña, alargada, conoidea, que parece una *Syrnola*. Ápice agudo. Teloconcha con las vueltas planas a ligeramente convexas. Sutura somera. Abertura suboval con un pliegue columelar oblicuo.

Dimensiones: 2,5 x 1 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Colli turinés, Italia (SACCO. 1892). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Odostomia turritella (Grateloup, 1828) (Figs. 88-92)

Auricula turritella Grateloup, 1828. *Bull. Hist. Nat. Soc. Lin. Bordeaux*, 2 (9): nº 72, 105.
Acteon bulimoides Grateloup, 1838. *Actes Soc. Lin. Bordeaux*, 10, 53: 275, lám. 6, figs. 44, 45.

Material examinado: 150 c.

Descripción: En COSSMANN Y PEYROT (1917). Ilustración en LOZOUET *ET AL.* (2001).

Concha (Figs. 88-91) muy pequeña, oval-conidea. Protoconcha (Fig. 92) obtusa, del tipo C. Teloconcha con las vueltas poco convexas, la última oval-alargada. Líneas de crecimiento ortoclinas. Abertura oval, aguda hacia arriba. Columela opistoclina replegada sobre sí misma, formando a menudo una fisura umbilical. Diente columelar inclinado, bien conspicuo.

Dimensiones medias: 3 x 1 mm.

Distribución cronoestratigráfica y geográfica: Mioceno inferior: Aquitaniense y Burdigaliense francés (COSSMANN Y PEYROT,1917 y LOZOUET *ET AL.*, 2001). Mioceno medio (Langhiense): Depresión del Vallés (VILLALTA *ET AL.*, 1968); La Pedrera, Barcelona.

Comentarios: LOZOUET *ET AL.* (2001) retoman el nombre más antiguo atribuido a Grateloup, pues contrariamente a lo que opinan COSSMANN Y PEYROT (1917) *"turritella"* Grateloup, 1828 nunca pudo estar pre-ocupada por *"turritellata"* Deshayes, por ser un nombre diferente y además haber sido descrita en 1864 (!).

Odostomia sp.1

Material examinado: 1 c, ligeramente inmadura.

Descripción: Concha diminuta tronco-cónica. Protoconcha del tipo A-II, con una espira de dos vueltas, prominente, que sobresale bastante del perfil de la primera vuelta de teloconcha. Vueltas planas, la última angulosa en la periferia. Sutura somera. Abertura romboide, con un diente columelar conspicuo, perpendicular a la columela.

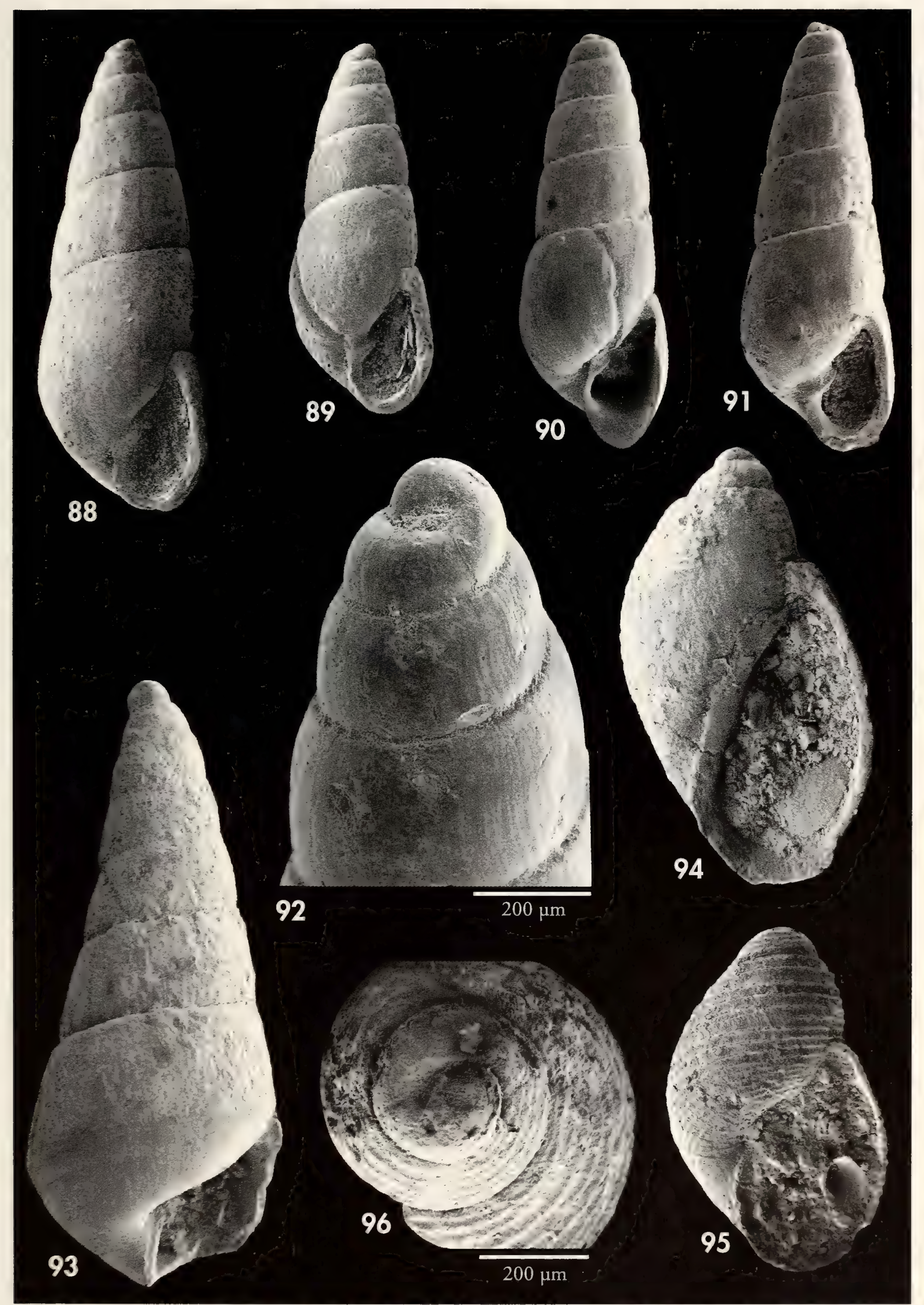
Dimensiones: 0,8 x 0, 4 mm.

Comentarios: Esta especie es muy parecida a *O. verhoeveni* Aartsen, Gittenberger y Goud, 1998, especie actual que vive en aguas del África Occidental, de la cual se diferencia casi únicamente en que ésta tiene una sutura profunda y canaliculada (ver ilustración en PEÑAS Y ROLÁN (1999).

Odostomia sp. 2 (Fig. 93)

Material examinado: 1 c.

Descripción: Concha pequeña, cónico-alargada, que parece una *Syrnola*. Ápice agudo con una protoconcha pequeña, del tipo B. Espira de la telo-



Figuras 88-92. *Odostomia turritella.* 88-91: conchas, 2,8, 2,2, 2,4 y 2,5 mm; 92: protoconcha. Figura 93. *Odostomia sp. 2.* Concha, 2,9 mm. Figuras 94-96. *Noemiamea batllorii.* 94: Concha, 1,6 mm; 95: holotipo, 1,3 mm; 96: protoconcha del holotipo.

Figures 88-92. Odostomia turritella. *88-91: shells, 2.8, 2.2, 2.4 and 2.5 mm; 92: protoconch. Figure 93.* Odostomia *sp.* 2. *Shell, 2.,9 mm. Figures 94-96.* Noemiamea batllorii. *94: Shell, 1.6 mm; 95: holotype, 1.3 mm; 96: protoconch of the holotype.*

concha elevada, con las vueltas planas, la última muy angulosa en la periferia, h < 50% H. Sutura somera. Sin escultura aparente. Abertura romboide, con un diente columelar estrecho, pero conspicuo, perpendicular a la columela. Ombligo estrecho pero profundo.

Dimensiones: 2,8 x 1,2 mm.

Comentarios: Esta especie tiene un gran parecido con *Syrnola lanotensis* (Lozouet, 1998) del Mioceno inferior (Aquitaniense), pero ésta última tiene una concha mayor y el pliegue columelar oblicuo.

Ondina sp.

Material examinado: 1 c juvenil.

Comentarios: La protoconcha de esta especie es cercana a la especie actual *O. obliqua* (Alder, 1844), pero no es posible describir la concha ni compararararla porque se trata de un juvenil con una sola vuelta de teloconcha

Noemiamea batllorii spec. nov. (Figs. 94-96)

Material tipo: Holotipo (Fig. 95) depositado en el MNCN (nº MNCNI- 37749). Paratipos en las siguientes colecciones: MVV (1) y MGSB (1).
Otro material estudiado: 5 c (Fig. 94) (una de ellas perdida durante el estudio).
Localidad tipo: Mioceno medio (Langhiense), La Pedrera, Sant Llorenç d'Hortons, (Barcelona).
Etimología: El nombre específico se dedica al Dr. Jordi Batllori, de la Universidad de Barcelona, por su colaboración en la realización de este trabajo.

Descripción: Concha (Figs. 94, 95) diminuta, ovoide. Protoconcha (Fig. 96) del tipo B, en forma de casquete. Espira de la teloconcha muy corta, con 2,0-2,5 vueltas que son ligeramente convexas, algo escalonadas, de crecimiento muy rápido, la última oval, muy grande, h = 90% H. Sutura estrecha pero profunda. Escultura espiral formada por numerosas estrías equidistantes, unas 10 entre las suturas de la última vuelta, siendo más numerosas y apretadas en la base. Sin escultura axial. Abertura oval, muy grande, > 70% H. Peristoma continuo. Columela arqueada, con un pliegue oblicuo, atrasado, conspicuo, aunque no prominente. No umbilicada.

Una de las conchas tiene la espira más corta y las estrías espirales son más numerosas, pero una única concha nos parece insuficiente material para darle nombre.

Dimensiones del holotipo: 1,3 x 0,7 mm. Dimensiones máximas: 1,6 x 0,9 mm.

Discusión: No hemos encontrado ningún género en el que esta especie pudiese ser claramente ubicada y creemos que *Noemiamea* es el más cercano, por sus caracteres genéricos: concha muy pequeña, globular-ovoide, con 2-3 vueltas de crecimiento rápido y perfil algo escalonado, con escultura espiral conspicua y sin escultura axial.

Por otra parte, presenta diferencias con las siguientes especies afines:

N. dolioliformis (Jeffreys, 1848), que vive en el Atlántico europeo y en el Mediterráneo, es más globosa, tiene la protoconcha del tipo A, es umbilicada y tiene un diente columelar prominente.

Acteopyramis merignacensis Cossmann y Peyrot, 1917, del Mioceno inferior (Burdigaliense y Aquitaniense) francés, tiene una concha mayor, con la espira más elevada, la protoconcha es obtusa, del tipo C y tiene la escultura espiral formada por surcos profundos más espaciados.

Acteopyramis elatus (Von Koenen, 1882), del Oligoceno alemán y *Kleinella ivolasi* (Mayer, 1900) del Mioceno medio belga y holandés, tienen la concha mayor, con la espira más elevada, el ápice obtuso y tienen una escultura espiral diferente, no formada por estrías sino por surcos más anchos con estrías verticales en su interior.

Turbonilla olivellai spec. nov. (Figs. 99-101)

Material tipo: Holotipo (Fig. 99) y dos paratipos, depositados en el MNCN (nos MNCNI- 37750 y 37751-2). Otros paratipos: MMP (2), MGSB (3), y MVV (2).
Otro material examinado: 20 c.
Localidad tipo: Mioceno medio (Langhiense), La Pedrera, Sant Llorenç d'Hortons, (Barcelona).
Etimología: El nombre específico se dedica a Rosendo Olivella, paleontólogo del Museu del Vi de Vilafranca del Penedès, por poner a nuestra disposición la colección paleo-malacológica del Museo.

Descripción: Concha (Figs. 99, 100) muy pequeña, cónica. Protoconcha (Fig. 101) algo obtusa, del tipo A-II, con un diámetro de 250 µm, y una espira de 1,5 vueltas, emergida. Unas 5-6 vueltas de teloconcha casi planas, algo angulosas en la zona sutural, la última angulosa en la periferia, h = 40% H. Sutura estrecha pero profunda, inclinada. Escultura axial no varicosa, formada por unas 12 costillas rectas, opistoclinas, delicadas, algo más estrechas que sus interespacios; unas y otros se atenuan hasta desaparecer en la periferia de la última vuelta. Sin escultura espiral. Abertura pequeña, romboide. Columela recta, vertical, sin pliegue aparente.

Dimensiones del holotipo: 2,1 mm x 0,7 mm. en 5 televueltas.

Discusión: Concha parecida a *T. obliqua* Degrange-Touzin, 1895, del Mioceno Helveciense y Burdigaliense francés, y del Crag británico, pero ésta tiene un mayor tamaño, la espira más elevada con vueltas más convexas y estrechas, las costillas más robustas, la sutura más profunda y ondulada, y tiene un pliegue columelar.

Nuestra especie es cercana a *T. incognita* Degrange-Touzin, 1895, del Mioceno inferior (Aquitaniense) francés, que fue insuficientemente descrita en base a un solo fragmento sin ápice ni primeras vueltas, y redescrita por COSSMANN Y PEYROT (1917: 352, lám. 10, figs. 72, 73). Se trata de una especie mucho mayor (H = 9 mm), con las vueltas aún más planas, la sutura más somera y las costillas más robustas, casi ortoclinas.

T. dertogracilis (Sacco, 1892), del Mioceno superior (Tortoniense) italiano y húngaro tiene una concha mayor, las costillas axiales son más anchas y obsoletas, algunas varicosas, que se desvanecen antes de la periferia de la última vuelta, la cual es redondeada; y tiene cordoncillos espirales visibles en el interior del labro externo.

T. astensidelicata Sacco, 1892, del Plioceno medio-superior italiano, tiene el ápice más agudo, la espira más elevada, y un mayor número de costillas (16-20), las cuales son robustas y más anchas que sus interespacios.

Tanto *T. costellatoides* Sacco, 1892, del Mioceno medio-superior italiano y del Plioceno italiano, como *T. costellata* Grateloup 1827, del Mioceno inferior (Aquitaniense y Burdigaliense) francés y del Mioceno medio de Dinamarca y Alemania, tienen una concha mucho mayor, con las vueltas bien convexas y la sutura más profunda, ambas tienen pliegue columelar y *T. costellata* tiene, además, una especie de cordón subsutural.

Turbonilla pliomagna Sacco, 1892

Turbonilla postacuticostata? var. pliomagna Sacco, 1892. *I Moll. ter. terz. Piem. e Lig.*, 11: 76, lám. 2, fig. 60.

Material examinado: 1 c, no adulta, 1 f.

Descripción: En SACCO (1892). Ilustración en FERRERO MORTARA *ET AL.* (1984: lám. 12, figs. 7a, 7b).

Dimensiones: 2,8 x 0,7 mm.

Distribución cronoestratigráfica y geográfica: Plioceno de Masserano, Italia (SACCO, 1892). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica

Según MICALI (*com. per.*) esta especie debe ser redescrita, ya que la considera válida y no una variedad de *T. postacuticostata* Sacco, 1892 nom. nov. pro *T. acuticostata* Jeffreys, 1884 non O. Speyer, 1870. No realizamos la redescripción en este trabajo debido al escaso material disponible.

Turbonilla sallomacensis Cossmann y Peyrot, 1917 (Figs. 97, 98)

Turbonilla (Pyrgolidium) sallomacensis Cossmann y Peyrot, 1917. *Conch. Néog. de l'Aquitaine*: 364, pl. 10, fig. 89, 90.

Material examinado: 3 c.

Descripción: Concha (Fig. 97) cónica, estrecha. Protoconcha (Fig. 98) pequeña, del tipo B, planispiral, con un diámetro de unas 200 µm. Teloconcha con las vueltas casi planas, que crecen rápidamente. Numerosas costillas axiales, rectas, ortoclinas, delicadas, atenuadas bajo la sutura, más anchas que sus interespacios. Unas y otros se prolongan en la base más allá de la periferia. Sin escultura espiral. Abertura pequeña, romboide. Columela algo opistoclina, replegada.

Dimensiones: 2 x 0,7 mm.

Distribución cronoestratigráfica y geográfica: Mioceno medio: Helveciense de Salles, Francia (COSSMANN Y PEYROT, 1917). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Turbonilla sp.1

Material examinado: 1 c

Descripción: Concha muy pequeña, subcilíndrica. Protoconcha del tipo A-II, con un diámetro de unas 230 µm, con una espira de 1,5 vueltas totalmente emergida y prominente. Teloconcha con las vueltas apenas convexas. Sutura somera. Escultura axial formada por unas 20 costillas estrechas, algo arqueadas, que se atenuan en la periferia de la última vuelta hasta desaparecer. Numerosas estrías espirales visibles con aumento. Abertura subcuadrangular. Columela vertical, sin pliegue visible.

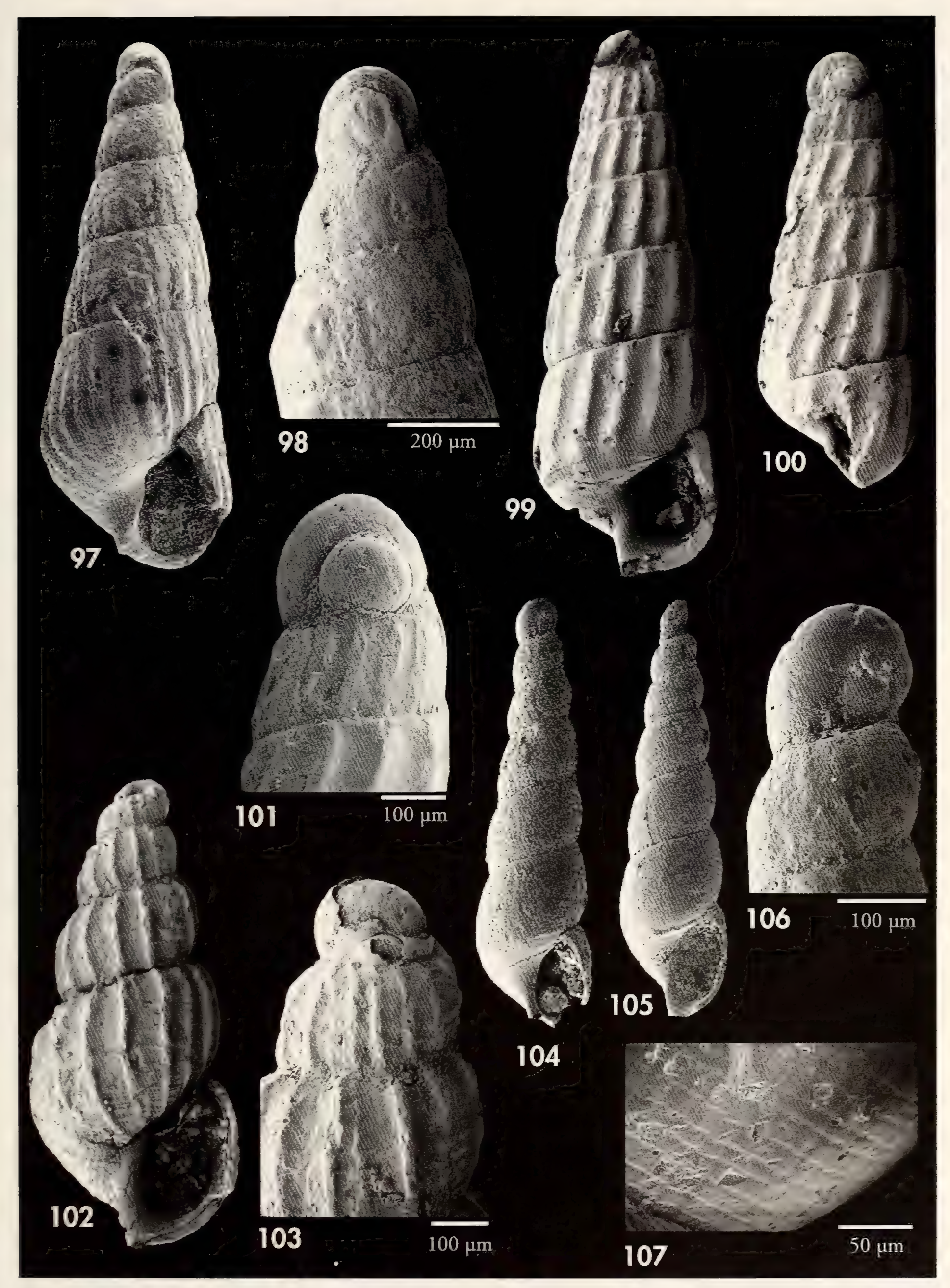
Dimensiones: 2,4 x 0,6 mm.

Comentarios: Esta especie tiene gran parecido con *T. templadoi* Peñas y Rolán, 1997, que vive en el África Occidental, en su tamaño, forma, tipo de protoconcha y microescultura espiral. Se diferencian en que ésta última tiene las vueltas más convexas, la sutura más profunda y la escultura espiral más conspicua.

Turbonilla sp. 2 (Figs. 102, 103)

Material examinado: 1 c.

Descripción: Concha (Fig. 102) pequeña, conoidea, algo pupoide. Protoconcha (Fig. 103) del tipo B, con un diámetro de unas 200 µm, con el núcleo y más de media vuelta visible. Teloconcha con las vueltas muy convexas, la última grande, h= 50% H. Sutura muy profunda. Escultura axial formada por unas 14 costillas lamelosas, 3-4 veces más estrechas que sus interespacios; unas y otros se prolongan en la base hasta la zona umbilical. Escultura espiral sola-



Figuras 97, 98. *Turbonilla sallomacensis.* 97: concha, 2,0 mm; 98: protoconcha. Figuras 99-101. *Turbonilla olivellai.* 99: holotipo, 2,1 mm; 100: concha, 1,7 mm; 101: protoconcha. Figuras 102, 103. *Turbonilla sp. 2.* 102: concha, 1,75 mm; 103: protoconcha. Figuras 104-107 *Anisocycla* cf. *bezanconi.* 104, 105: conchas, 1,5 y 1,6 mm; 106: protoconcha; 107: detalle de la escultura.
Figures 97, 98. Turbonilla sallomacensis. *97: shell, 2.0 mm; 98: protoconch. Figures 99-101.* Turbonilla olivellai. *99: holotype, 2,1 mm; 100: shell,*1,7 *mm; 101: protoconch. Figures 102, 103.* Turbonilla *sp. 2. 102: concha, 1.75 mm; 103: protoconcha. Figures 104-107.* Anisocycla *cf.* bezanconi. *104, 105: shells, 1.5 and 1.6 mm; 106: protoconch; 107: detail of the sculpture.*

mente en los interespacios, formada por pocas estrías espirales equidistantes que, en la base, son mucho más numerosas y apretadas. Abertura oval. Columela opistoclina, muy replegada hacia la zona umbilical.

Dimensiones: 1,75 x 0,76 mm.

Comentarios: Esta especie pertenece al grupo de *T. jeffreysii* (Jeffreys, 1848) y *T. rufescens* (Forbes, 1846) por su forma y escultura axial lamelosa; sin embargo, difiere de ellas en la forma de la protoconcha, en la escultura espiral y en la forma de la columela.

Anisocycla cf. *bezanconi* Cossmann y Lambert, 1884 (Figs.104-107)

Anisocycla bezançoni (Cossmann y Lambert) sensu Gougerot, 1991. *Bull. Nat. Parisiens*, 47 (1): 8.

Material examinado: 5 c.

Descripción: Concha diminuta (Figs. 104, 105), ligeramente subcilíndrica, alargada, muy frágil. Protoconcha (Fig. 106) del tipo B, planispira, con un diámetro de unas 180 µm, con el núcleo visible, y la sutura de separación con la teloconcha muy angulosa. Espira elevada, con las vueltas convexas, de crecimiento regular, la última oval redondeada. Sutura profunda. Escultura espiral (Fig. 107) delicada formada por débiles surcos relativamente equidistantes. Sin escultura axial salvo las líneas de crecimiento, ligeramente arqueadas, algo opistoclinas bajo la sutura. Abertura oval. No umbilicada.

Dimensiones: 1,6 x 0,5 mm.

Distribución cronoestratigráfica y geográfica: Oligoceno de la Cuenca de París (GOUGEROT, 1991). Mioceno inferior (Aquitaniense) Saucats, Francia (LOZOUET *ET AL*., 2001). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

GOUGEROT (1991) cree que esta especie, procedente del Oligoceno, muy probablemente no difiera de *A. scalarina* (Deshayes, 1861) del Eoceno parisino e incluye en el mismo taxon 2 ejemplares del Aquitaniense de Las Landas. LE RENARD (1998) designa un neotipo de *A. scalarina*, el cual presenta claras diferencias con *A. bezanconi*. Por otra parte, LOZOUET *ET AL*. (2001) ponen en duda la sinonimia de ambas especies, opinión que compartimos. Creemos que se trata de dos especies diferentes: *A. bezanconi* sería antecesora de la actual *A. nitidissima* (Montagu, 1803), mientras que *A. scalarina* sería antecesora de *A. striatula* (Jeffreys, 1856).

Anisocycla eulimoides Fekih, 1969 (Figs. 108, 109)

Anisocycla eulimoides Fekih, 1969. *Notes du Service Geologique, Tunis*, 29: 57, lám. 11, fig. 15.

Material examinado: 2 c.

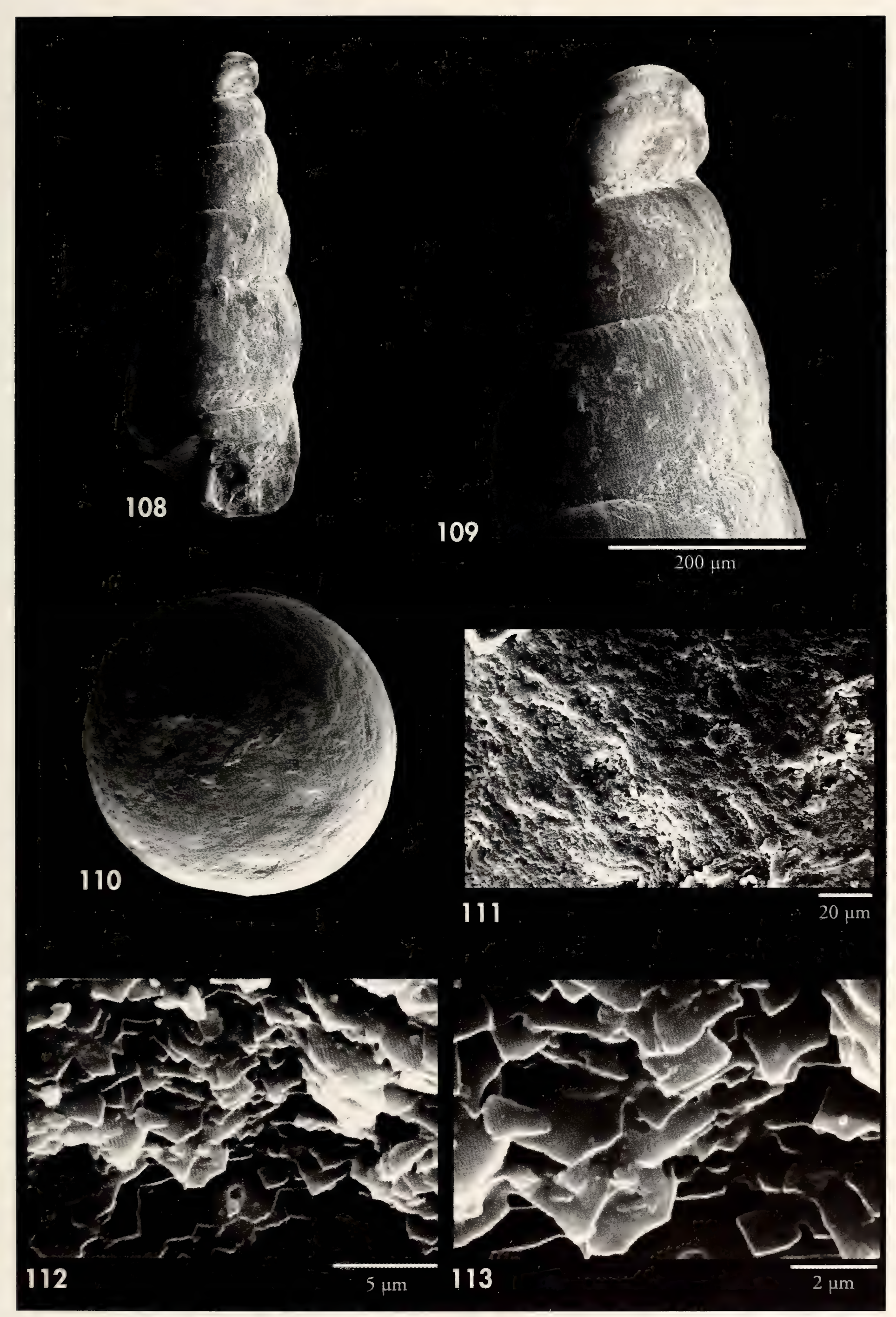
Descripción: En FEKIH (1969).

Mostramos concha (Fig. 108) y protoconcha (Fig. 109), del tipo B, planispira, con la sutura muy inclinada. Resaltamos el rápido crecimiento de las vueltas, tanto en anchura como en altura, siendo la última muy grande, con más del 50% de la altura total. Se aprecia en la zona subsutural que las líneas de crecimiento son muy numerosas, prosoclinas, y en la última vuelta se observa solamente a gran aumento una tenue escultura espiral.

Dimensiones: 1,35 x 0,45 mm.

Distribución cronoestratigráfica y geográfica: Plioceno de Oued el Galea, Túnez (FEKIH, 1969). Mioceno medio (Langhiense): La Pedrera, Barcelona.

Comentarios: Esta es la primera cita para el Mioceno de la Península Ibérica.



Figuras 108, 109. *Anisocycla eulimoides.* 108: concha, 1,3 mm; 109: protoconcha. Figuras 110-113. Perla. 110: perla, diámetro de 0,69 mm; 111-113: detalle de la estructura laminar.
Figures 108, 109. Anisocycla eulimoides. *108: shell, 1.3 mm; 109: protoconch. Figures 110-113. Pearl. 110: pearl, diameter of 0.69 mm ; 111-113: detail of the laminar structure.*

Esta especie, descrita para el Plioceno de Túnez, presenta unas claras diferencias con el resto de especies de este género, sean fósiles o vivientes: su relación H/h = 2 y su relación H/D = 3.

Clathrella sulcosa (Brocchi, 1814)

Nerita sulcosa Brocchi, 1814. *Conch. fos. subap.*, 298, lám. 1, figs. 3a, b.

Material examinado: 1 f.

Comentarios: Ver en PEÑAS Y ROLÁN (2001) ilustración del holotipo y su comparación con la especie actualmente viviente en aguas del África Occidental, *Clathrella volumen* Peñas y Rolán, 2001.

Clase BIVALVIA

Anadara cf. *diluvii* (Lamarck, 1805)

Arca diluvii Lamarck, 1805. *Ann. Mus. Nation. Hist. Nat. Paris*, 219.

Material examinado: 40 c, 220 v.

Dimensiones máximas: 30 x 20 mm.

Distribución cronoestratigráfica y geográfica: Esta especie ha sido citada en todas las cuencas europeas desde el Burdigaliense hasta la actualidad.

Comentarios: Especie polimorfa. CALZADA (1982) denominó a este bivalvo como *Scapharca (Cunearca)* sp., después del estudio de material procedente de Can Rosell, Sant Pau d'Ordal y La Pedrera. Este autor comparó este taxon con *Anadara fichteli, Scapharca turonica, Anadara numida* y *Anadara diluvii,* concluyendo que era diferente a las especies citadas, aunque reconociendo una cierta similitud con *Anadara diluvii* var. *pertransversa.* Ciertamente, la especie actualmente viviente presenta claras diferencias con el fósil miocénico.

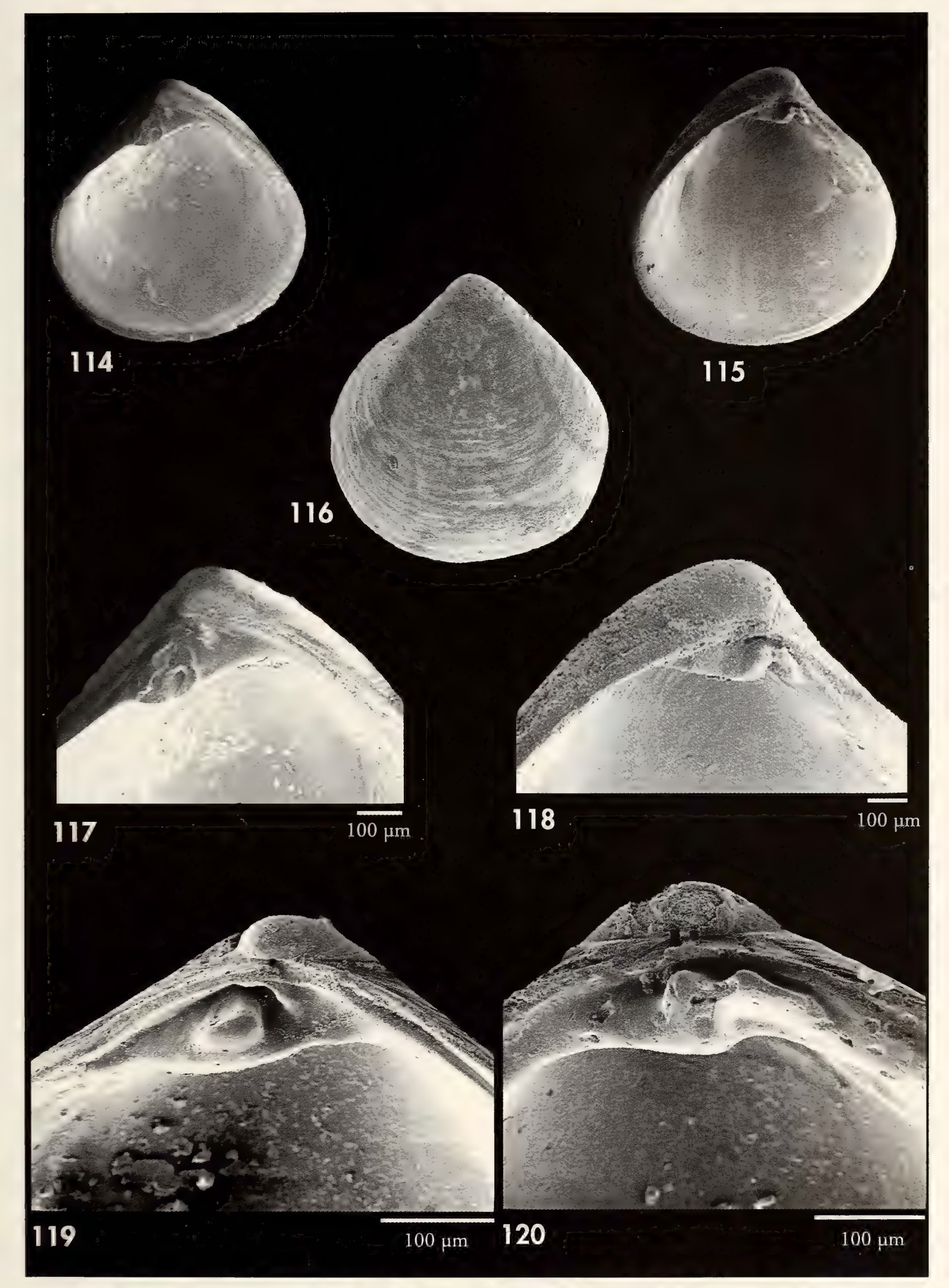
Ostrea edulis Linné, 1758 (Figs. 110-113)

En la fracción fina del sedimento tamizado se halló un diminuto cuerpo esférico, de aspecto nacarado (Fig. 110), con un diámetro de 687,5 µm. Creimos que podía tratarse de una perla producida probablemente por algún ejemplar de *Ostrea edulis*, especie común en el yacimiento, y se procedió a fotografiarla al MEB (Figs. 111-113) con 600, 4.810 y 9.621 aumentos. Las fotografías revelan la estructura concéntrica e irregular de las capas laminares semiabiertas típica de las perlas. En las de mayor aumento se observa la estructura laminar y puntualmente la forma subexagonal de los cristales de aragonita característica de las perlas. Nogués (com. per.) nos confirma que se trata de una perla, a pesar de tener su superficie bastante deteriorada.

Ver estructura microscópica de las capas de la perla en NOGUÉS, VENDRELL Y ARBUNIES (1980).

Alveidus nitidus (Reuss, 1867) (Figs. 114-120)

Spaniodon nitidus Reuss, 1867. *Sitzungsber. D. Kais. Akad. D. Wiss.*, 55 (1): 135-136, lám. 8, figs. 3a, b.



Figuras 114-120. *Alveidus nitidus.* 114: valva derecha; 115: interior de la valva derecha; 116: interior de la valva izquierda; 117: charnela de la valva derecha; 118: charnela de la valva izquierda.119: detalle de la charnela de la valva derecha; 120: detalle de la charnela de la valva izquierda.

Figures 114-120. Alveidus nitidus. *114: right valve; 115: inner part of the right valve; 116: inner part of the left valve; 117: hinge of the right valve; 118: hinge of the left valve; 119: detail of the hinge of the right valve; 120: detail of the hinge of the left valve.*

Lutetia girondica Benoist in coll. Cossmann y Peyrot, 1912. *Actes Soc. Lin. Bordeaux*: 610-612, lám. 26, figs. 16-19.

Material examinado: Más de 300 c, más de 5.000 v.

Descripción: En COSSMANN Y PEYROT (1912) y en A W. JANSSEN (1984). Se ilustran aquí la concha y la charnela en detalle.

Dimensiones: 1,2 x 1,2 mm.

Distribución cronoestratigráfica y geográfica: Oligoceno superior (ANDERSON, 1964). Mioceno inferior: Burdigaliense y Aquitaniense de Francia (COSSMANN Y PEYROT, 1912). Mioceno medio: Winterswijk-Miste, Holanda (JANSSEN, 1984); Badeniense del sur de Polonia (STUDENCKA, 1986). Mioceno medio (Langhiense): La Pedrera, Barcelona. Mioceno superior: Tortoniense de Saubrigues, Francia (COSSMANN Y PEYROT, 1912).

Comentarios: Ésta es la primera cita para el Mioceno de la Península Ibérica.

Se trata de la especie predominante de este yacimiento, tanto en número de ejemplares como en volumen de sedimento estudiado. De esta minúscula especie se han contado en la fracción fina del nivel A cerca de 1.000 valvas por centímetro cúbico, además de unos dos ejemplares completos (las dos conchas unidas) de media y gran cantidad de fragmentos. Teniendo en cuenta que el volúmen estudiado de esta fracción es de unos tres litros y medio, calculamos que en él se encuentran unos tres millones de valvas, sin contar los fragmentos. Además, hemos constatado que más del 85% de esa fracción fina del sedimento resultante del lavado está formado por valvas y fragmentos de esta especie. En el nivel B el volumen de esta especie es mucho menor que en el nivel A.

STUDENCKA (1986) discute la ubicación genérica de esta especie.

CASANOVAS *ET AL*. (1972) la consideran en otro género, como *Polimesoda* sp. (Calzada, *com. per.*).

3. Comentarios finales

Especies previamente citadas en La Pedrera, no encontradas por nosotros: Se relacionan seguidamente las especies citadas anteriormente en este yacimiento, indicando a continuación el autor o autores de la cita en negrita. No se incluyen las que consideramos sinonimias ni los moluscos determinados a nivel genérico: CRUSAFONT (1959): **C**; CASANOVAS, CALZADA Y SANTAFÉ (1972): **CCS**; MARTINELL Y PORTA (1981): **MP**; BATLLORI (1995): **B**; NAVAS *ET AL*. (1996): **N**.

Teinostoma degrangei	N
Pleurotoma monilis	C
Turritella cestacensis	C
Bittium reticulatum	N
Cerithium olivaeformis	B
Cerithium turonicum	B
Seila turritellata	CS
Opalia branderburgi	MP
Calyptraea cf. costaria	N
Pereiraea gervaisi	MP, N
Xenophora testigera	B
Euspira protracta	N
Ficus cingulatus	N
Ficus conditus	B
Sinum haliotoideum	B
Triton abbreviatus	B
Trunculariopsis turonensis	MP, N
Murex delbosianus	B
Murex vindobonensis	MP, B
Columbella curta	B
Nassarius borsoni	N
Nassarius brugnoni?	B
Nassarius elatus	B
Nassarius hoernessi?	B
Nassarius orthezensis	N
Nassarius prismaticus	N
Nassarius rectus	B
Babylonia brugadina	B
Athleta ficulina	B, N
Pusionella pseudofusus	C
Eulimella subumbilicata	B
Spondylus deshayesi	N
Thracia dollfusi	N
Meretrix ericina	C

Nuevas citas para la Península ibérica y nuevas especies para la ciencia: Como se señaló anteriormente, en el listado de especies se identifican con un asterisco aquellas que, de acuerdo con la bibliografía, se citan por primera vez para este yacimiento, que son 29 en total. Con dos asteriscos se señalan las que son primera cita para la Península Ibérica, 40 en total. De ellas son nuevas para la ciencia las siguientes: *Obtusella orisparvi, Caecum verai, Eulimella penedesensis, Noemiamea batllorii* y *Turbonilla olivellai.*

Debemos resaltar el gran número de taxones citados a nivel genérico: 33, bastantes de ellos difícilmente determinables por la escasez y mal estado de conservación del material. Sin embargo, varios de ellos (como *Rissoa* sp., *Bela* sp.2, *Syrnola* sp. o *Venus* sp.), de los que se ha encontrado suficiente material, precisan de una revisión para la cual es necesaria la consulta de numerosos trabajos muy dispersos, actualmente no accesibles para nosotros.

Abundancia relativa: Tan solo doce de las especies encontradas en este yacimiento representan más del 95% del total de ejemplares hallados en nuestros muestreos. Se relacionan a continuación, por orden de mayor a menor abundancia en número de ejemplares: *Alveidus nitidus, Sandbergeria perpusilla, Acteocina lajonkairena, Nassarius* cf. *aturensis, Obtusella orisparvi, Potamides theodiscus, Granulolabium pictum, Hydrobia peregrina; Chrysallida cimbrica, Nassarius girondicus, Odostomia turritella y Cyllene vulgatissima.*

Como ya se comentaba anteriormente *Alveidus nitidus* debe ser considerada la especie predominante de este yacimiento, tanto en número de ejemplares como en volúmen conchífero. Entre los gasterópodos, *Sandbergeria perpusilla* es la especie más abundante en número de ejemplares y *Potamides theodiscus* la que representa el mayor volúmen conchífero.

CONCLUSIONES

El presente trabajo confirma la riqueza malacológica de este yacimiento de La Pedrera, para el cual, el número total de especies de moluscos marinos fósiles conocidos actualmente es de 194 (169 Gasterópodos, 22 Bivalvos y 3 Escafópodos). En este trabajo, recolectadas por los autores, se citan 160 especies (138 Gasterópodos, 19 Bivalvos y 3 Escafópodos).

En nuestra opinión la fauna malacológica hallada pertenece al nivel infralitoral somero de un ambiente típico marino, equivalente a la fauna actualmente existente en ese nivel, con una cierta influencia de agua dulce, dada la abundante presencia de hidróbidos.

Se constata asimismo la escasa información ofrecida sobre micromoluscos, aunque no de otros microfósiles, en anteriores trabajos paleontológicos referidos a este yacimiento y a la Península Ibérica en general, que es casi nula si se trata del período miocénico.

AGRADECIMIENTOS

Nuestro agradecimiento a los siguientes profesores de la Universidad de Barcelona: al Dr. Jordi Batllori, por su ayuda en la determinación de algunas especies y por permitirnos consultar su colección; al Dr. Carles Martín, que nos mostró el yacimiento y nos facilitó información sobre el mismo; al Dr. Carles Gili por su ayuda en la revisión de la familia Nassariidae; al Dr. Jaume de Porta por su ayuda en la determinación de la familia Ostreidae; al Dr. Salvador Reguant y a su ayudante Yael Díaz por la determinación del briozoo; al Dr. Joaquín María Nogués por su asesoramiento y ayuda en la identificación de la perla; a Nuria Martínez por su ayuda en la determinación de algunos bivalvos. A los padres del primero de los autores y a José L. Cañadas por acompañarnos durante la recogida de muestras. A Laia Fonollà, quien nos mostró la zona de estudio. A Pasquale Micali, de Fano, Italia, por su ayuda en la clasificación de varias especies, especialmente de Pyramidellidae, y en la obtención de bibliografía. Al Dr. Pierre Lozouet, del MNHN, por su ayuda y revisión de las familias Potamididae y Batillariidae y cesión de mate-

rial. Al Dr. Sebastián Calzada, director del MGSB y al Dr. Antonio Abad por sus comentarios, sugerencias y ayuda en la obtención de bibliografía. Al Dr. José Luis Vera Peláez del Museo Municipal de Paleontología de Estepona, por su ayuda y revisión de las familia Turridae y la clase Scaphopoda. Al Dr. Gonzalo Giribet, de la Universidad de Harvard, por el envío de bibliografía. A la Dra. Bárbara Studenka del Muzeum Ziemi de Polonia por su ayuda en la determinación de *Alveidus nitidus*. A Jesús Méndez, del CACTI, de la Universidad de Vigo, por las fotos al MEB. A los Drs. Martinell, Domenech, Vera-Peláez y también a Pasquale Micali, a Rafael Muñiz y a Carlo Chirli que leyeron el manuscrito y aportaron con sus críticas y sus opiniones la base para mejorarlo.

Este trabajo ha sido parcialmente subvencionado por un proyecto de la XUNTA DE GALICIA PGIDTO-OPXI30121PR.

BIBLIOGRAFÍA

AARTSEN, J. J. VAN, 1987. European Pyramidellidae. II. *Odostomia* and *Ondina*. *Bollettino Malacologico*, 23 (1-4): 1-34.

ADAM, W. Y KNUDSEN, J., 1969. Quelques genres de mollusques prosobranches marins inconnus ou peu connus de l'Afrique Occidentale. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 44 (27): 1-69

ALMERA, J., 1896. Reconocimiento de la presencia del primer piso mediterráneo en el Penedés. *Real Sociedad de las Ciencias y Artes de Barcelona*, 3ª época, 1: 348-394.

ANDERSON, H. J., 1964. Die miocene Teinbeck-Stufe in Nord-und Westdeutschland und ihre Mollusken-Fauna. *Fortschritte in der Geologie von Rheinland und Westfalen*, 14: 31-390.

BALUK, W., 1970. The Lower Tortonian at Niskowa near Norwy Sacz. *Acta Geologica Polonica*, 20 (1): 1-157.

BALUK, W., 1975. Lower Tortonian Gastropods from Korytnica, Poland. Part. 1. *Paleontologia Polonica*, 32: 1-186, 21 láms.

BALUK, W., 1997. Middle Miocene (Badenian) gastropods from Kortynica, Poland; part III. *Acta Geologica Polonica*, 47 (1-2): 1-75, 25 láms.

BASTEROT, B. DE, 1825. Mémoire Géologique sur les environs de Bordeaux. Première partie comprenant les observations générales sur les mollusques fossiles, et la description particulière de ceux qu'on rencontre dans ce bassin. *Mémoires de la Société d'Histoire Naturelle de Paris*, 2: 1-100, 7 láms.

BATLLORI, J., 1990. *Estudio malacológico del yacimiento de La Pedrera (Sant Llorenç d'Hortons)*. Tesis de Licenciatura, Univ. de Barcelona, 171 pp., 8 láms.

BATLLORI, J., 1995. *Gasterópodos del Mioceno medio marino del Alt Penedès (Catalunya)*. Tesis Doctoral, Univ. de Barcelona, 592 pp., 30 láms.

BATLLORI, J. Y GARCÍA, J. J., 1996. Un caso de parasitismo en Balanidae (Cirripeda) sobre Gastropoda en el Mioceno catalán. *Malakos*, 5: 53-56.

BATLLORI, J. Y MARTINELL, J., 1992. Actividad predadora en moluscos del Mioceno del Penedés (Cataluña). *Revista Española de Paleontología*, 7 (1): 24-30.

BATLLORI, J. Y MARTINELL, J., 1993. Malacofauna del Mioceno salobre de Cerdanyola del Vallès (Catalunya): aspectos paleoecológicos. *Iberus*, 11 (1): 1-8.

BELLARDI, L., 1882. I Molluschi dei terreni terziarii del Piemonte e della Liguria. Parte 3. Gasteropoda (Buccinidae, Cyclopsidae, Purpuridae, Coralliophilidae, Olividae). *Memorie della Reale Academia delle Scienze di Torino*, 34 (2): 219-469, 12 láms.

BOETTGER, O., 1906. Zur Kenntnis der Fauna der mittelmiozänen Schichten von Kostej im Krassó-Szörényer Komitat. *Verhandlungen und Mitteilungen des siebenbürgischen Vereins für Naturwisschenschaften Hermannnstadt*, 54-55: 1-244.

BRUSINA, S., 1877. Fragmenta Vindobonensia. *Journal de Conchyliologi*, 25: 368-391.

BURNAY, L. P. Y FERNANDES, F., 1984. Notícia da ocorrência em Angola do género *Eunaticina* Fischer, 1885, com descrição de una nova espécie (Gastropoda, Naticidae). *Publicaçôes Ocasionais da Sociedade Portuguesa de Malacologia*, 3: 1-9.

CALZADA, S., 1982. *Scapharca (Cunearca)* sp. del Mioceno del Penedés (provincia de Barcelona). *Estudios Geológicos*, 38: 399-404.

CALZADA, S., SANTAFÉ, J. Y CASANOVAS, M. L., 1978. Nuevos datos sobre el Mioceno inferior marino del Vallès (sector Cerdanyola). *Acta Geológica Hispánica*, 13 (4): 113-116.

CASANOVAS, M.L., CALZADA, S. Y SANTAFÉ, J. V., 1972. Contribución al estudio del Mioceno del Penedés (sector Gelida). *Acta Geológica Hispánica*, 7 (5): 143-148.

CHIRLI, C., 1995. Il genere *Caecum* Fleming, 1817 nel Plioceno Toscano. *Bollettino Malacologico*, 31 (1-4): 21-27.

COSSMANN, M., 1921. *Essais de Paléoconchologie comparée*. Vol 12. París, 349 pp., láms A-D, I-IV.

COSSMANN, M. Y PEYROT, A.,1912. Conchologie néogenique de l'Aquitaine. Pélécypodes (Clavagellidae a Lucinidae). *Actes de la Société Linnéenne de Bordeaux*, 65: 429-728, láms. 19-21.

COSSMANN, M. Y PEYROT, A., 1917-1919 Conchologie néogenique de l'Aquitaine. Tome 3. 1 livraison. *Actes de la Société Linnéenne de Bordeaux*, 69-70: 1-491, láms. 1-17.

CRUSAFONT, M., 1959. La segunda fase transgresiva en el Vindoboniense del Vallés-Penedés. *Noticiario y comunicados del Instituto Geológico y Minero Español*, 55: 3-16.

CRUSAFONT, M. Y TRUYOLS, J., 1954. Sinopsis estratigráfico-paleontológica del Vallés-Penedés. *Arrahona*, 4: 1-15.

FEKIH, M., 1969. Pyramidellidae récoltés dans le Pliocène de l'Oued El Galea (Menzel Bourguiba). *Notes du Service Geologique*, Tunis, 29: 7-81.

FERRERO MORTARA, E., MONTEFAMEGLIO, L., PAVIA, G. Y TAMPERI, R., 1984. *VII Catalogo dei tipi degli exemplari della collezione Bellardi-Sacco. Parte II.* Salvestrini and Cappelloto, Torino, 484 pp, 56 láms.

GLIBERT, M., 1949. Gastropodes du Miocène moyen du bassin de la Loire (1ere. partie). *Memoire de l'Institut Royal des Sciences naturelles de Belgique*, ser. II, 30: 1-240, 12 láms.

GLIBERT, M., 1952a. Gastropodes du Miocène moyen du bassin de la Loire (deuxième partie). *Memoire de l'Institut des Sciences naturelles de Belgique*, ser. II, 46: 241-450, 15 láms.

GLIBERT, M., 1952b. Faune malacologique du Miocène moyen de la Belgique. II. Gastropodes. *Memoire de l'Institut des Sciences naturelles de Belgique*, 121: 1-197, 10 láms.

GOUGEROT, L., 1991. Les spèces d'*Anisocycla* Monterosato du Paléocène et de l'Eocène francais (Gastropoda, Pyramidellidae) – En appendice: Iconographie des *Anisocycla* actuelles. *Cahiers des Naturalistes, Bulletin des Naturalistes Parisiens*, n.s., 47 (1): 1-25.

GRATELOUP, S. DE, 1832. Tableau des coquilles Fossiles qu'on rencontre dans les terrains calcaires tertiaires (faluns) des environs de Dax, dans le département des Landes. *Actes de la Société Linnéenne de Bordeaux*, 6e article: 5,30: 314-344.

HARMER, F. W., 1915. The Pliocene Mollusca of Great Britain, being supplementary to S.V. Wood's Monograph of the Crag Mollusca. Vol. 1. *Palaeontographical Society, London* (1915): 201-302.

HARMER, F. W., 1921. The Pliocene Mollusca of Great Britain, being supplementary to S. V. Wood's Monograph of the Crag Mollusca. Vol. 2, part 2. *Palaeontographical Society, London* (1921): 653-705, láms. 53-56.

JANSSEN, A. W., 1963. Gastropoda uit de Belgische "Sables de Vieux Joncs" en de Nederlandse "Cerithiumklei" (oligoceen). *Basteria*, 27 (3-4): 45-67.

JANSSEN, A. W., 1972. Die Mollusken-Fauna der Twistringer Schichten (Miöcan) von Norddeutschland. *Scripta Geologica*, 10: 1-95.

JANSSEN, A. W., 1984. *Mollusken uit het Mioceen van Winterswijk-Miste.* Amsterdam, Leiden, 451 pp., 82 láms.

JANSSEN, R., 1979. Die Mollusken des Oberoligozäns (Chattium) im Nordsee-Becken. 2. Neogastropoda. Euthyneura, Cephalopoda). *Archiv für Molluskenkunde*, 109 (4-6): 277-376, láms. 15-18, 18a.

JEFFREYS, G., 1884. On the Mollusca procured during the Lightning and Porcupine Expeditions. VIII. *Proceedings of the Zoological Society of London* (1884): 341-372.

LE RENARD, J., 1998. *Anisocycla* Monterosato, 1880 (Mollusca: Gastropoda), un genre victime d'un artifice nomenclatural analysé: la sysonymisation par restriction hétérotypique. *Cossmanniana*, 5 (3-4): 109-114.

LINDEN, J. VAN DER Y EIKENBOOM, J. C. A., 1992. On the taxonomy of the Recent species of the genus *Chrysallida* (Carpenter) from Europe, the Canary Islands and the Azores. *Basteria*, 56 (1-3): 3-64.

LÓPEZ-CIVIT, C., 1984. *La microfauna d'ostràcodes del Miocè de l'Alt Penedès.* Tesis doctoral, Univ. De Barcelona, 412 pp., 61 láms.

LOZOUET, P., 1998. Nouvelles espèces de Gasteròpodes (Mollusca: Gastropoda) de l'Oligocène et du Miocène inférieur de l'Aquitaine (Sud-Ouest de la France). *Cossmanniana*, 5 (3-4): 61-102, 19 figs.

LOZOUET, P., LESPORT, J.F. Y RENARD, F., 2001. Révision des Gastropoda (Mollusca) du Stratotype de l'Aquitaine (Miocène inf.): site de Saucats "Lariey", Gironde, France. *Cossmanniana*, hors série nº 3: 1-189.

MAGNÉ, J., 1978. *Etudes microstratigraphiques sur le neogene de la Méditerranée nord-occidental. Vol. I: Les bassins néogènes catalans.* Editions du C.N.R.S., Centre Regional de Publications de Toulouse, Sciences de la Terre, 259 pp., 87 lams.

MARQUET, R., 1997a. Pliocene gastropod faunas from Kallo (Ost-Vlaanderen, Belgium). Par 2. Caenogastropoda: Potamididae to Tornidae. *Contribution of Tertiary and Quaternary Geology*, 34 (1-2): 9-29.

MARQUET, R., 1997b. Pliocene gastropod faunas from Kallo (Oost-Vlaanderen, Belgium). Part 3. Caenogastropoda: Aporrhaidae to Muricidae, and Part 4. Buccinidae to Helicidae. *Contribution of Tertiary and Quaternary Geology*, 34 (3-4): 69-149.

MARTINELL, J. Y PORTA, J., 1981. Presencia de *Vaginella austriaca* Kittl (Pteropoda) y fauna malacológica acompañante en el Mioceno de Cataluña. *Iberus*, 1: 1-8, 2 láms.

MORGAN, J. DE, 1920. Contribution a l'ètude de la faune des Faluns de la Touraine. *Bulletin de la Société Géologique de France*, 19: 305-343.

MORONI, M. A. Y RUGGIERI, G., 1988. Su due piccoli Cerizi del Miocene superiore italiano. *Bollettino Malacologico*, 24 (5-8): 133-140.

NAVAS, E., MARTINELL, J., DOMENECH, R. Y BATLLORI, J., 1996. Correlación bioestratigráfica entre las sucesiones miocénicas marinas de Sant Pau d'Ordal y Sant Llorenç d'Hortons (Depresión del Vallès-Penedès, Barcelona). *Acta Geológica Hispánica*, 29 (2-4): 149-168.

NOGUÉS, J. M., VENDRELL, M. Y ARBUNIES, M., 1980. Structure microscopique des couches de la perle. *Revue de Gemmologie, Association française de Gemmologie*, 64: 10-12.

NORDSIECK, F., 1972. *Die Miozäne Molluskenfauna von Miste-Winterswijk NL (Hemmoor)*.Gustav Fischer Verlag, Stuttgart: 350 pp., 35 láms.

PAVIA, G., 1966. I molluschi del Pliocene inferiore di Monteu Roero (Alba, Italia NW). *Bollettino della Società Paleontologica Italiana*, 14 (2): 101-183.

PAVIA, G., 1975. I molluschi del Tabiniano del Basso Monferrato (Alba, Italia NW). *Bollettino della Società Paleontologica Italiana*, 14: 99-175.

PEÑAS, A. Y ROLÁN, E., 1997. La familia Pyramidellidae Gray, 1840 (Mollusca, Gastropoda, Heterostropha) en África Occidental. 2. Los géneros *Turbonilla* y *Eulimella*. *Iberus*, Suplemento 3: 1-105.

PEÑAS, A. Y ROLÁN, E., 1999. La familia Pyramidellidae Gray, 1840 (Mollusca, Gastropoda, Heterostropha) en África Occidental. 4 Los géneros *Megastomia, Odostomia, Ondina, Noemiamea* y *Syrnola*. *Iberus*, supl. 5: 1-150.

PEÑAS, A., Y ROLÁN, E., 2001. The superfamily Pyramidelloidea Gray, 1840 (Mollusca, Gastropoda, Heterostropha) in West Africa. 9. The genus *Clathrella*. *Iberus*, 19 (2): 101-106.

PEÑAS, A., TEMPLADO, J. Y MARTÍNEZ, J. L., 1996. Contribución al conocimiento de los Pyramidelloidea (Gastropoda: Heterostropha) del Mediterráneo español. *Iberus*, 14 (1): 1-82.

PEREIRA DA COSTA, F. A., 1866. Molluscos fosseis. Gastropodes dos depositos terciarios de Portugal. *Commissão Geologica de Portugal*, 1: 1-116, 15 láms.

PEYROT, A., 1928. Conchologie Néogénique de l'Aquitaine. *Actes de la Société Linnéenne de Bordeaux*, 79 suppl.: 5-264.

PONDER, W. F., 1985. The anatomy and realtionships of *Elachisina* Dall (Gastropoda: Rissoacea). *Journal of Molluscan Studies*, 51: 23-34.

PORTA, J. DE, MARTINELL, J. Y GONZÁLEZ DELGADO, J. A., 1993. Caecidae (Gastropoda, Mesogastropoda) del Neógeno y Cuaternario marinos del Mediterráneo noroccidental y de la Península Ibérica. *Revista Española de Paleontología*, 8 (1): 1-13.

ROLÁN, E. Y RUBIO, F., 2002. The family Tornidae (Gastropoda, Rossoidea) in the East Atlantic. *Suppl. Reseñas Malacológicas*, 13: 1-98.

SABELLI, B., GIANUZZI-SAVELLI, R. & BEDULLI, D., 1991. *Catalogo annotato dei molluschi marini del Mediterraneo*. Librería Naturalistica Bolognese, Bologna, vol. 1, 348 pp.

SACCO, F., 1892. *I molluschi dei terreni terziarii del Piemonte e della Liguria. Parte XI. Eulimidae e Pyramidellidae*. Carlo Clausen, Torino, 99 pp.

SALAJ, J., 1971. Remarques microbiostratigraphiques sur le Miocène de Penedés dans la Dépresión prélitorale Catalane. *Notes su Service Geologique de Tunisie*, 40: 113-116.

SCHANDER, C., 1994. Twenty-eight new species of Pyramidellidae (Gastropoda, Heterobranchia) fromWest Africa. *Notiziario C.I.S.M.A.*, 15: 11-78.

SORGENFREI, T., 1958. *Molluscan assamblages from the marine midle Miocene of South Jutland and their environments*. C. A. Reitzel Publisher, Copenhagen: 503 pp. + 76 láms. (2 vol.).

STRAUSZ, L., 1966. *Die Miözan-Mediterranen Gastropoden Ungars*. Akadémiay Kiadò, Budapest, 693 pp.

STUDENCKA, B., 1986. Bivalves from the Badenian Middle Miocene marine sandy facies of Suthern Poland. *Palaeontologia Polonica*, 47: 3-128, 18 láms.

TABANELLI, C., 1991. Contributo alla conoscenza della malacofauna del Pliocene batiale di Romagna: descrizione di alcune nuove specie. *Bollettino Malacologico*, 27 (1-4): 49-55.

TRUYOLS, J. Y CRUSAFONT, M., 1951. Caracterización de un sistema de cuñas marinas en el Mioceno del Penedés. *Estudios Geológicos*, 7 (14): 443-454.

VERA-PELÁEZ, J.L., LOZANO-FRANCISCO, M.C., MUÑIZ-SOLIS, R., GILI, C., MARTINELL, J., DOMÈNECH, R., PALMQVIST, P. Y GUERRA-MERCHÁN, A., 1996. Estudio preliminar de la malacofauna del Plioceno de Estepona (Málaga, España). *Iberus*, 13 (2): 93-117.

VILLALTA, J.F. Y ROSELL, J., 1966. Aportaciones al estudio del Mioceno marino de la comarca del Vallès. *Acta Geológica Hispánica*, 1: 5-8.

VILLALTA, J.F., ROSELL, J. Y OBRADOR, A., 1968. Una nueva aportación al conocimiento del Mioceno marino del Vallés. *Acta Geológica Hispánica*, 3 (1): 19-21.

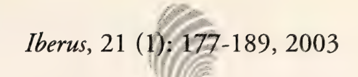
WARÉN, A., 1980. Marine Mollusca described by John Gwyn Jeffreys, with the location of the type material. *Conchological Society of Great Britain anbd Ireland, Special Publication* 1: 1-60, 8 láms.

WIENRICH, G., 2001. *Die Fauna des marinen Miozäns von Kevelaer (Niederrhein). Band 3. Gastropoda bis Cancellariidae.* Backhuys Puplishers BV, Leiden,: 387-639.

WOOD, S.V., 1848. *A monograph of the Crag Mollusca. Part 1. Univalves.* Paleontographical Society, London: 208 pp., 21 láms.

ZICH, A., 1934. Zur fauna des Mittel-Miöcans von Kostej (Banat), Typus-Bestimmung und Tafeln zu O. Boettger's Bearbeitungen. *Senckenbergiana*, 16 (4-6): 193-302.

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Adiciones a la fauna malacologica del litoral del Garraf (NE de la Península Ibérica)

Additions to the malacological fauna of El Garraf (NE of the Iberian Peninsula)

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Recibido el 15-VII-2002. Aceptado el 27-I-2003

RESUMEN

Se presenta una segunda lista de 54 especies de moluscos marinos (47 gasterópodos y 7 bivalvos), no citados previamente, recolectados en aguas del Garraf (Barcelona, NE de la Península Ibérica). De estas especies, 18 se citan por primera vez en el Mediterráneo español, siendo una de ellas, *Pseudosetia ficaratiensis*, la primera cita, probablemente actual, en el Mediterráneo. Además, se cita por primera vez en el Mediterráneo el género *Bathycrinicola* (Eulimidae), describiendo una nueva especie. Se incluyen, asimismo, comentarios sobre algunos de los taxones mencionados y se ilustran al microscopio electrónico de barrido (MEB) varios de ellos.

ABSTRACT

A complementary list of new citations of marine mollusks from waters of El Garraf (Barcelona, NE Iberian Peninsula) is presented. The new list includes 54 species of marine mollusks (47 gastropods and 7 bivalves). From these, 18 are first reports for the Spanish Mediterranean, including the first recent specimens of *Pseudosetia ficaratiensis* from the Mediterranean. The genus *Bathycrinicola* (Eulimidae) is also reported for the Mediterranean for the first time, including a new species. Some of the taxa are discussed and illustrated at the scanning electron microscopy (SEM).

PALABRAS CLAVE: Moluscos marinos, Garraf, NE Península Ibérica, Mar Mediterráneo, nueva especie.
KEY WORDS: Marine mollusks, Garraf, NE Iberian Peninsula, Mediterranean Sea, new species.

INTRODUCCIÓN

En el trabajo de GIRIBET Y PEÑAS (1997), en el que se citaron 622 especies de moluscos marinos (7 poliplacóforos, 417 gasterópodos, 190 bivalvos y 8 escafópodos), quedó patente la gran riqueza malacológica de los fondos marinos situados frente a la pequeña comarca del Garraf, En dicho trabajo, al cual nos remitimos, se delimitó la zona de estudio, incluyendo un mapa, y se describió la variedad y particularidad de sus fondos.

Se constató también que, probablemente, el Garraf sea la zona del Mediterráneo español más exhaustivamente estudiada hasta la fecha, pues se citaron 53 especies por primera vez en él, siendo dos de ellas primera cita para todo el Mediterráneo.

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Posteriormente, GIRIBET Y PEÑAS (1999) describieron en la zona una nueva especie para la ciencia: *Epilepton parrusetensis*. PEÑAS Y ROLÁN (2000) citaron también en esta zona *Turbonilla postacuticostata* Sacco, 1892.

El presente trabajo es una continuación de los anteriores, y el resultado del estudio de nuevo material. Se han encontrado 255 especies, 201 de las cuales ya fueron citadas anteriormente, en fondos de similares características. Por tanto, en este trabajo se citan solamente las 54 especies que son nuevas en la zona (47 gasterópodos y 7 bivalvos). En total, se conocen hasta la fecha en el litoral de la comarca del Garraf 678 especies de moluscos marinos.

La base de este trabajo ha sido el estudio de nuevos sedimentos obtenidos en la zona, por tanto referido a conchas, si bien en varias de ellas se encontraron restos de partes blandas.

MATERIAL Y MÉTODOS

La mayor parte del material objeto del presente trabajo fue recolectado entre octubre y diciembre de 1996 por la embarcación de pesca de arrastre "Joven Mateo", del puerto de Vilanova i la Geltrú (Barcelona).

El 22 de octubre de 1996 se obtuvieron unos 10 litros de detrito en el caladero denominado "Mar de Nacra", a 7,25 millas de la costa, frente a Sitges (entre las pedanías de Vallcarca y Garraf), a una profundidad de 105 metros. El lugar es un fondo arenoso-fangoso, con una densa población de *Leptometra phalangium* (Müller, 1841) y donde hace años era muy abundante *Atrina pectinata* (Linnaeus, 1767). Los equinodermos fueron pescados vivos, aunque se fragmentaron por efecto del arrastre, y representaron casi la mitad del volumen obtenido. Una vez lavado el sedimento y pasado por una serie de tamices, siendo el más fino de 0,3 mm de luz de malla, se obtuvieron 0,8 litros de arenas silíceas y materia orgánica (sin contar los restos de crinoideos), rica en micromoluscos, especialmente los gasterópodos, muchos de ellos con restos de partes blandas.

El 12 de diciembre de 1996 se obtuvieron unos 12 litros de sedimento en el lugar denominado "El Vinyet", al sur de Sitges, a una profundidad de 160 metros, en fondo fangoso. Una vez lavado y tamizado, se obtuvieron unos 2,5 litros de material formado básicamente por restos de bivalvos. El sedimento era pobre en especies vivas, excepto de las familias Nuculidae y Thyasiridae.

Entre los meses citados, se analizó el contenido estomacal de unos 200 ejemplares de *Astropecten irregularis* (Linck), dragados entre 150 y 250 metros de profundidad, frente a Vilanova i la Geltrú.

Gran cantidad de ejemplares pertenecientes a la familia Janthinidae fueron recogidos, la mayoría con restos de partes blandas, durante los veranos de 1998 y 1999 en las playas de Cubelles por los malacólogos Ramón Beneito y Vicente Buñuel.

Se han fotografiado al microscopio electrónico de barrido aquellas especies nuevas para la zona sobre las que se aporta información adicional.

El listado de especies ha sido confeccionado básicamente de acuerdo con la nomenclatura de la CLEMAM (Check List of European Marine Mollusca: http://www.mnhn.fr/cgi-bin/mamlist).

Abreviaturas utilizadas:

MNCN: Museo Nacional de Ciencias Naturales, Madrid.
c: significa concha
v: valva
H: altura total de la concha
h: altura de la última vuelta
D: diámetro
=: aproximadamente igual

RESULTADOS

En el nuevo material estudiado se han identificado 255 especies, la mayoría ya citadas por GIRIBET Y PEÑAS (1997). Por tanto, en el presente trabajo

sólo se relacionan las especies no citadas previamente, que en total son 54 (47 gasterópodos y 7 bivalvos), 4 de ellas identificadas solamente a nivel genérico.

En la Tabla I se ofrece una relación de estas 54 especies, indicando cuáles de ellas se citan por primera vez para el Mediterráneo español o para el Mediterráneo en general. La especie irá en negrita cuando sea objeto de comentarios. Se señala, asimismo, el lugar de recolección, su abundancia relativa y las especies ilustradas.

COMENTARIOS SOBRE ALGUNOS TÁXONES

De la mayoría de especies citadas en este trabajo existen fotografías y descripciones actualizadas. Por tanto, en este apartado nos hemos limitado a comentar algunos de los taxones que nos han parecido de mayor interés, ya sea por su rareza o por que se aporta nueva información. Además incluimos la descripción de una nueva especie para la ciencia perteneciente a la familia Eulimidae.

Clase GASTROPODA

Tricolia deschampsi Gofas, 1993

Tricolia deschampsi Gofas, 1993. *J. Moll. Stud.*, 59: 354-356, figs. 6-8, 19, 29, 30.

Material examinado: 3 c, procedentes del "Mar de Nacra", Sitges, dragadas a 105 m de profundidad.

Comentarios: Esta especie, cuya determinación no nos ofrece dudas, es abundante en el infralitoral y circalitoral del estrecho de Gibraltar y Mar de Alborán. La cita en el Garraf representa la localización más al norte del Mediterráneo español.

Tricolia tingitana Gofas, 1982

Tricolia tingitana Gofas, 1982. *J. Moll. Stud.*, 48: 202-205, figs. 54-64.

Material examinado: 4 c, procedentes del "Mar de Nacra", Sitges, dragadas a 105 m de profundidad; 1 c, procedente de "El Vinyet", al sur de Sitges, dragada a 160 m de profundidad.

Comentarios: Esta especie fue descrita para la zona del estrecho de Gibraltar y para Calvi, Cerdeña. Posteriormente, GOFAS (1993) amplió su área de distribución al sur de Portugal y banco atlántico de Gorringe. Además, revisó el material de Córcega y llegó a la conclusión que pertenecía a una especie diferente, que describió como *T. punctura*. De esta forma, la cita en el Garraf representa la localización más oriental y septentrional del Mediterráneo español.

Bathycrinicola nacraensis spec. nov. (Figs.4-7)

Material tipo: Holotipo (Fig. 4) y un paratipo, ambos con dimensiones de 1,2 x 0,5 mm y 4 vueltas de espira, depositados en el MNCN (nº 15.05/46482) , ambos procedentes del "Mar de Nacra", Sitges, dragado a 105 metros de profundidad.
Localidad tipo: "Mar de Nacra", Sitges, provincia de Barcelona (España), a 7,25 millas de la costa, a 105 m de profundidad.
Etimología: El nombre específico proviene del caladero en el que ha sido encontrada por primera vez, el "Mar de Nacra". Nacra proviene del Catalán, y es el nombre común con el que se conocen los bivalvos de la familia Pinnidae.

Tabla I. Relación de las especies encontradas en el área de estudio, lugar donde se han encontrado, figuras en las que se representan y abundancia relativa. Las especies en negrita se comentan en el texto. Códigos. *: primera cita en el Mediterráneo español; **: primera cita en el Mediterráneo o nueva cita para la ciencia; n: Mar de Nacra; v: El Vinyet; e: estrellas; c: Cubelles; +: 1-2 ejemplares; ++: 3-10 ejemplares; +++: más de 10 ejemplares.

*Table I. Checklist of species found in the area of study, location within the area, figures where the species are represented, and abundante. Species in boldface are discussed in the text. Codes. *: first record for the Spanish Mediterranean; **: firs record for the Mediterranean or new species; n: Mar de Nacra; v: El Vinyet; e: in starfish gut contents; c: Cubelles; +: 1-2 specimens; ++: 3-10 specimens; +++: more than 10 specimens.*

Clase GASTROPODA		
Familia SCISSURELLIDAE		
Scissurella costata D'Orbigny, 1842: n		++
Familia SKENEIDAE		
Skenea serpuloides (Montagu, 1808): n		+
* *Lissomphalia bithynoides* (Monterosato, 1880): n, v	Figs. 1-2	++
Dikoleps marianae Rubio, Dantart y Luque, 1998: n		+++
Anekes turrita (Gaglini, 1987): n		++
* *Palazzia ausoniae* (Palazzi, 1988): n	Fig. 3	+
Familia TRICOLIIDAE		
Tricolia deschampsi Gofas, 1993: n		++
Tricolia tingitana Gofas, 1982: n, v		++
Familia TRIPHORIDAE		
Monophorus thiriotae Bouchet, 1984: n		+
Familia CERITHIOPSIDAE		
* *Cerithiopsis fayalensis* Watson, 1886: n, v		+++
Familia JANTHINIDAE		
Janthina nitens Menke, 1828: c		+++
Janthina pallida W. Thompson, 1840: c		+++
Familia ACLIDIDAE		
Aclis minor (Brown, 1827): n		+
Familia EPITONIIDAE		
Epitonium tiberii (de Boury, 1890): n, v		++
Acirsa subdecussata (Cantraine, 1835): n		++
Familia EULIMIDAE		
** ***Bathycrinicola nacraensis*** spec. nov.: n	Figs. 4-7	+
* *Crinophtheiros comatulicola* (Graft, 1875): n		+
Curveulima devians (Monterosato, 1884): n, v		++
Vitreolina antiflexa Monterosato, 1884: n		++
Vitreolina curva (Monterosato, 1874 ex Jeffreys ms.): n		+
Vitreolina incurva (Bucquoy, Dautzenberg y Dollfus, 1883): n, v		+++
Familia RISSOIDAE		
Alvania hispidula (Monterosato, 1884): n		++
Alvania lanciae (Calcara, 1841): n		+
* ***Alvania*** sp.: n	Figs. 8-10	+
Pusillina parva (Da Costa, 1778): n	Figs. 11-12	+
* ***Pusillina*** sp.: e	Figs. 13-14	+
** ***Pseudosetia ficaratiensis*** (Brugnone, 1876): n, e	Figs. 15-16	++

Tabla I. Continuación.
Table I. Continuation.

Familia CAECIDAE		
Caecum subannulatum De Folin, 1870: n		++
Familia ATLANTIDAE		
Atlanta fusca Souleyet, 1852: n		+
Atlanta inflata Souleyet, 1852: n. v		++
Familia FIROLIDAE		
* *Firoloida desmarestia* Lesueur, 1817: n		++
Familia CONIDAE		
Raphitoma erronea (Monterosato, 1884): n		++
Raphitoma histrix (Bellardi, 1847): n		+
Raphitoma pseudohystrix (Sykes, 1906): v		+
Familia CIMIDAE		
* ***Cima*** sp.: n	Figs. 17-20	+
Familia PYRAMIDELLIDAE		
* ***Tiberia octaviana*** Di Geronimo, 1973: n	Fig. 21	+
Chrysallida multicostata (Jeffreys, 1884): n, v		++
Miralda elegans (De Folin, 1870): n		+
Odostomella bicincta (Tiberi, 1868): n		+
Eulimella neoattenuata Gaglini, 1992: v		++
Ondina crystallina Locard, 1892: n, v		++
Ondina warreni (W. Thompson, 1845): n		+
Familia ACTEONIDAE		
Acteon monterosatoi Dautzenberg, 1889: n		+
Familia DIAPHANIDAE		
Colpodaspis pusilla M. Sars, 1870: n		+
Familia RETUSIDAE		
Retusa mamillata (Philippi, 1836): n		+
Familia PHILINIDAE		
Philine punctata (J. Adams, 1800): n		+
* ***Philine striatula*** Monterosato, 1874: n		+
Clase BIVALVIA		
Familia YOLDIIDAE		
* ***Microgloma pusilla*** (Jeffreys, 1879): n,		+
Familia LIMIDAE		
Limatula subovata (Jeffreys, 1876): n		++
* ***Limatula*** sp.: n		+
Familia THYASIRIDAE		
* *Thyasira alleni* Carrozza, 1981: n, v		++
Familia MONTACUTIDAE		
* ***Montacuta semirubra*** Gaglini, 1992: n		+
* *Kelliopsis jozinae* van Aartsen y Carrozza, 1997: n, v		++
Familia MESODESMATIDAE		
* *Monterosatus primus* (Locard, 1899): n		+

Descripción: Concha diminuta (Fig. 4), cónico-piramidal, transparente, muy brillante. Protoconcha (Figs. 5-7) lisa, globosa, de casi 1,5 vueltas, con la sutura de separación con la teloconcha casi vertical, con un diámetro de unas 200 µm. Teleoconcha de 2,5 vueltas convexas, la última ancha, redondeada, h > 60% H. Sutura estrecha pero profunda. Superficie lisa, sin trazos de escultura, con excepción de las líneas de crecimiento, muy tenues, que son ortoclinas, salvo justo bajo la sutura donde son prosoclinas. Abertura circular. Columela arqueada, delgada, cortante, tras la cual se encuentra un ombligo pequeño pero profundo.

Discusión: Creemos que el hospedador de esta especie debe ser *Leptometra phalangium* (Müller, 1841), dado el hábitat en el que ha sido encontrada, aunque no ha sido observada sobre este crinoideo. Ambas conchas se encontraron con restos de partes blandas.

BOUCHET Y WARÉN (1986) describen el nuevo género *Bathycrinicola*, para eulímidos de profundidad parásitos de crinoideos e incluyen en él cinco especies atlánticas. Sólo una de ellas, *B. curta* (Warén, 1972), tiene una protoconcha parecida, pero el resto de características morfológicas es diferente: concha postlarval mayor, más estrecha y alargada, con las vueltas menos convexas, la sutura es muy somera y carece de ombligo.

Hemos ubicado esta especie en el género *Bathycrinicola* como el más adecuado, al considerarla parásita de un crinoideo y por el tipo de protoconcha. Las conchas pertenecientes al género *Umbilibalcis* también son umbilicadas, pero tienen un perfil muy cónico, con numerosas vueltas, y tienen una microescultura conspicua formada por surcos axiales.

Es la primera vez que este género se cita para el Mediterráneo.

Alvania sp. (Figs. 8-10)

Material examinado: 1 c, en el "Mar de Nacra", Sitges, dragada a 105 m. Dimensiones: 2,4 x 1,3 mm.

Comentarios: Se trata de una concha (Fig. 8) probablemente rodada, con la protoconcha (Figs. 9, 10) gastada, en la que no se aprecia bien la escultura. A pesar de ello, no se asemeja a ninguna de las especies descritas en el Mediterráneo ni Atlántico próximo. Solamente *A. cimicoides* (Forbes, 1844) tiene un perfil parecido, pero presenta la escultura conspicua, una sutura canaliculada y, sobre todo, su protoconcha es multiespiral, mientras que en *Alvania* sp. es pauciespiral.

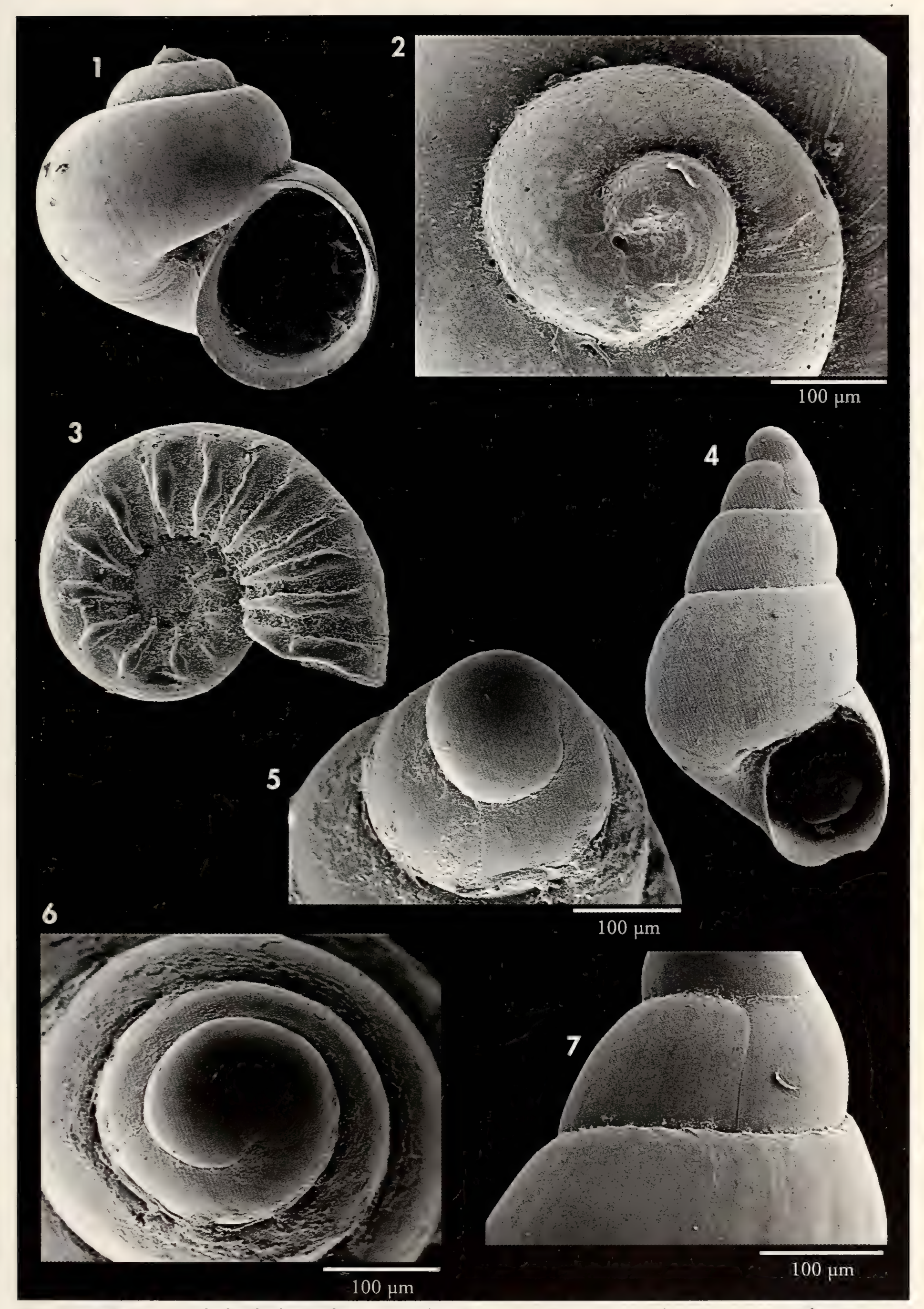
Pusillina sp. (Figs. 13, 14)

Material examinado: 2 c, en *Astropecten irregularis*, a 150-250 m de profundidad. Dimensiones máximas 2,7 x 1,3 mm.

Comentarios: Esta especie se caracteriza por carecer de la escultura, presente en la mayoría de las pertenecientes a este género, si bien su color blanquecino con débiles flámulas verticales amarillentas es típico de él. Los ejemplares hallados recuerdan alguna forma de *P. interrupta* (J. Adams, 1800), que podría haber sido transportada a esas cotas batimétricas pues, excepto *P. inconspicua* (Alder, 1844), ninguna otra especie de este género vive en las aguas profundas del Mediterráneo.

Pseudosetia ficaratiensis (Brugnone, 1876) (Figs. 15, 16)

Rissoa ficaratiensis Brugnone, 1876. *Miscellanea Malacologica*, pars 2: 21.



Figuras 1-2. *Lissomphalia bithynoides.* 1: concha, 0,8 mm; 2: protoconcha. Figura 3. *Palazzia ausoniae.* Concha, 0,57 mm. Figuras 4-7. *Bathycrinicola nacraensis.* 4: holotipo, 1,2 mm; 5, 6: protoconcha; 7: detalle de la sutura.

Figures 1-2. Lissomphalia bithynoides. *1: shell, 0.8 mm; 2: protoconch. Figure 3.* Palazzia ausoniae. *Shell, 0.57 mm. Figures 4-7.* Bathycrinicola nacraensis. *4: holotype, 1.2 mm; 5, 6: protoconch; 7: detail of the suture.*

Material examinado: 4 c, 2 en *Astropecten irregularis* (Linck), frente a Vilanova i la Geltrú, entre 150 y 250 m; 2 en el "Mar de Nacra", Sitges, a 105 m de profundidad.

Descripción: En BOUCHET Y WARÉN (1993: 688-690, figs. 1595-1596, 1613, 1614). Se muestra aquí una concha (Fig. 15), con unas dimensiones de 1,5 x 0,9 mm y su protoconcha (Fig. 16), con un diámetro de unas 335 µm.

Distribución: Especie solamente conocida en aguas profundas entre el Estrecho de Gibraltar y el suroeste de Portugal, y como fósil Plio-Pleistoceno en Sicilia. Esta es la primera vez que se cita en el Mediterráneo, creemos que como fauna actual, ya que dos de las conchas estudiadas, si bien carecían de partes blandas, eran frescas.

Cima sp. (Figs. 17-20)

Material examinado: 1 c, procedente del "Mar de Nacra", Sitges, dragada a 105 m de profundidad.

Descripción: Concha (Figs. 17, 18) muy pequeña, conoidea alargada, blanca vítrea. Dimensiones 1,3 x 0,5 mm. Protoconcha (Figs. 19, 20) grande y globosa, más bien heterostrofa, con un diámetro de 165 µm. Teleoconcha con las vueltas convexas de rápido crecimiento, la última grande, oval-redondeada, h= 50% H. Sutura profunda. Abertura oval. Columela arqueada. No umbilicada.

Comentarios: Esta rara especie parece tener características cercanas a *Aclis*, *Eulimella* y *Cima*. La protoconcha recuerda algunas formas de *Eulimella*, especialmente *E. similebala* Peñas y Rolán, 1999, de los bancos atlánticos submarinos al sur de las Azores, pero en ella se observa claramente la sutura del núcleo. A pesar de que parece más cercana al género *Aclis*, hemos optado por ubicar provisionalmente esta especie en la familia Cimidae, por las características de la protoconcha heterostrofa, aunque distinta a las conocidas de la familia Pyramidellidae.

Tiberia octaviana Di Geronimo, 1973 (Fig. 21)

Tiberia octaviana Di Geronimo, 1973. *Conchiglie*, 9(11-12): 217-222.

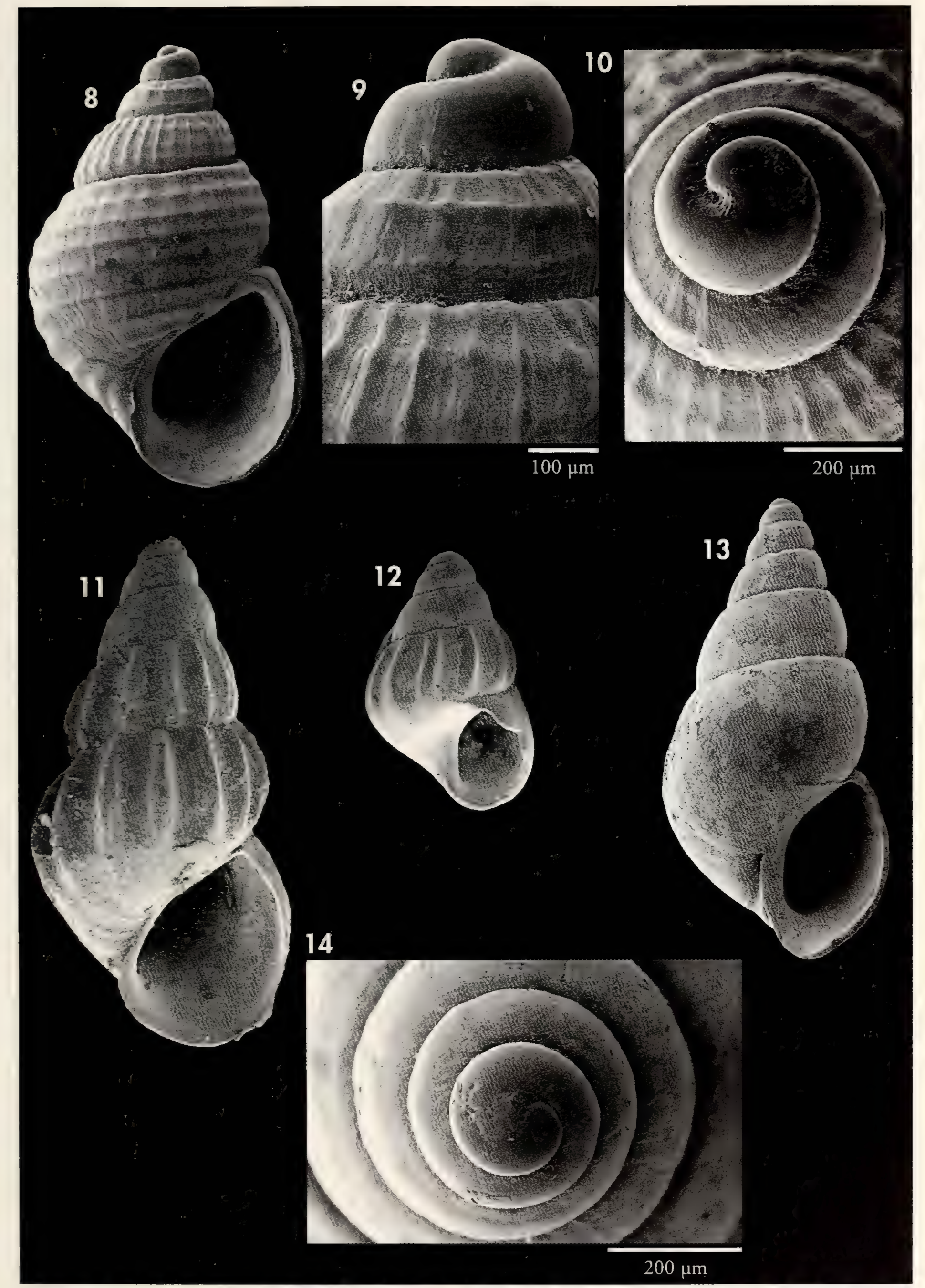
Material examinado: 1 c, procedente del "Mar de Nacra", Sitges, dragada a 105 m. de profundidad.

Descripción: En DI GERONIMO (1973). Se muestra aquí la concha encontrada (Fig. 21).

Distribución: Sólo conocida en aguas de Catania, Italia. Esta es la primera cita en el Mediterráneo español.

Se muestra aquí una concha con unas dimensiones de 5,3 x 2,1 mm.

Comentarios: Esta especie, descrita con dos únicos ejemplares, ha sido considerada dudosa o una forma más esbelta de *T. minuscula* Monterosato, 1880. El único ejemplar recolectado ha sido comparado con varias conchas de *T. minuscula* de la misma comarca del Garraf, con las cuales presenta diferencias. La concha se ajusta a la descripción original no sólo en su forma y relación H/D, sino en las bandas de color marrón que son más anchas que en *T. minuscula*, además de tener una tercera banda periumbilical más difuminada. Seguramente el estudio de un mayor número de ejemplares podría confirmar que *T. octaviana* y *T. minúscula* son dos especies diferentes, como creemos, sin formas intermedias.



Figuras 8-10. *Alvania sp.* 8: concha, 2,4 mm; 9-10: protoconcha. Figuras 11, 12. *Pusillina parva.* 11: concha, 3,4 mm, Vigo; 12: concha, 1,8 mm, Garraf. Figuras 13, 14. *Pusillina sp.* 13: concha, 2,7 mm; 14: protoconcha.

Figures 8-10. Alvania sp. *8: shell, 2.4 mm; 9-10: protoconch. Figures 11, 12.* Pusillina parva. *11: shell, 3.4 mm, Vigo; 12: shell, 1.8 mm, Garraf. Figures 13, 14.* Pusillina sp. *13: shell, 2.7 mm; 14: protoconch.*

Miralda elegans De Folin, 1870

Mathilda elegans De Folin, 1870. *Les Fonds de la Mer*, 1: 212, 213, pl. 28, fig. 15.
Pyrgulina sculptatissima Dautzenberg, 1913. *Ann. Inst. Océanogr.*, 1:67, 68, lám. 3, figs. 15-16.
Chrysallida pulchra Gaglini, 1992. *Argonauta*, 7(1-7): 138, 139, fig. 146.

Material examinado: 1 c, procedente del "Mar de Nacra", Sitges, dragada a 105 m.

Comentarios: Esta especie, típica del África Occidental, fue citada en el Mediterráneo por HOENSELAAR Y MOOLENBEEK (1990: 65-66, figs. 1-4) en Formentera, Baleares, y por GAGLINI (1992: 138, 139, fig. 146) como *Chrysallida pulchra* en Sicilia. Esta es la primera cita para el Mediterráneo español peninsular.

Philine striatula Monterosato, 1874 ex Jeffreys MS

Philine striatula Monterosato, 1874. *Journal de Conchyliologie*, 22: 281.

Material examinado: 1 c, procedente del "Mar de Nacra", Sitges, dragada a 105 m.

Descripción: En OLIVERIO Y TRINGALI (2001: 138, 139), quienes ilustran un sintipo (figs. 73-75).

Comentarios: OLIVERIO Y TRINGALI (2001) en su revisión de los tipos de los Opistobranquios descritos por Monterosato dan validez a esta especie encontrada en aguas profundas de Sicilia. Aquí se cita por primera vez en el Mediterráneo español.

Clase BIVALVIA

Microgloma pusilla (Jeffreys, 1879)

Leda pusilla Jeffreys, 1879. *Proc. Zool. Soc. London*, 581, pl. 46, fig. 6.

Material examinado: 2 v, procedentes del "Mar de Nacra", Sitges, dragadas a 105 m.

Comentarios: Ver ilustración en SALAS (1996: figs. 58-61), quien incluye esta especie en la familia Pristiglomidae, y la cita para aguas profundas frente al Cabo San Vicente, Portugal, y frente a Rabat, Marruecos. Aquí se cita por primera vez en el Mediterráneo español.

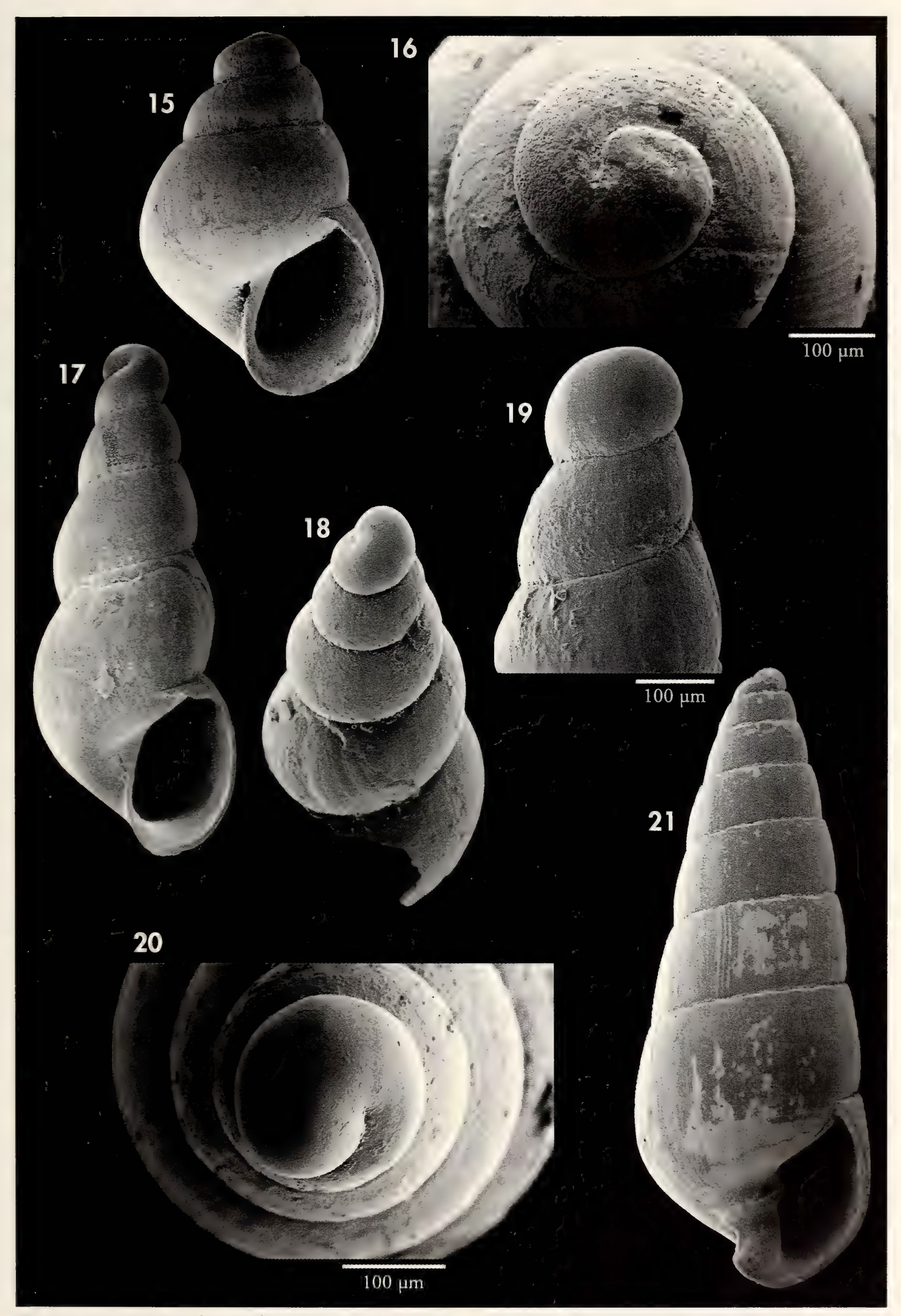
Limatula sp.

Material examinado: 3 v, procedentes del "Mar de Nacra", Sitges, dragadas a 105 m.

Comentarios: Las 3 valvas encontradas, ninguna completa, se corresponden con el ejemplar citado en GIRIBET Y PEÑAS (1997) como *Limatula* cf. *gwyni* (Sykes, 1903), sin escultura radial aparente, pero con las líneas concéntricas de crecimiento muy marcadas.

Montacuta semirubra Gaglini, 1992

Montacuta semirubra Gaglini, 1992. *Argonauta*, 7(1-6): 178, 179, figs. 165-166.
Montacuta semirubra Monterosato, 1872 (nomen nudum)



Figuras 15, 16. *Pseudosetia ficaratiensis.* 15: concha, 1,5 mm; 16: protoconcha. Figuras 17-20. *Cima sp.* 17, 18: concha, 1,3 mm; 19-20: protoconcha. Figura 21. *Tiberia octaviana.* Concha, 5,3 mm.
Figures 15, 16. Pseudosetia ficaratiensis. *15: shell, 1.5 mm; 16: protoconch. Figures 17-20.* Cima sp. *17, 18: shell, 1.3 mm; 19-20: protoconch. Figure 21.* Tiberia octaviana. *Shell, 5.3 mm.*

Material examinado: 2 v, procedentes del "Mar de Nacra", Sitges, dragadas a 105 m.

Comentarios: En el trabajo de GAGLINI (1992: 178, 179, figs, 165-166) puede verse la descripción e ilustración de esta especie, cuya localidad tipo es Palermo, Sicilia. Se cita por primera vez para el Mediterráneo español.

CONCLUSIONES

Como se señaló anteriormente, se han identificado con un asterisco las especies que se citan por primera vez para el Mediterráneo español, que son 18 (12 Gasterópodos y 6 Bivalvos), 4 a nivel genérico. De ellas, *Pseudosetia ficaratiensis* se cita por primera vez reciente en el Mediterráneo en general y *Bathycrinicola nacraensis* se describe como nueva especie para la ciencia.

Este nuevo estudio reafirma lo constatado en el primer trabajo de los autores: la presencia en el Garraf de la mayoría de la malacofauna típica del Mediterráeo español (exceptuando la endémica del Mar de Alborán y estrecho de Gibraltar).

También podemos confirmar que la costa situada frente a El Garraf, a pesar de su escasa extensión, es una zona muy rica en moluscos marinos, debido a la diversidad de sus fondos. Hasta el presente se han citado en la comarca 678 especies, 69 por primera vez para el Mediterráneo español, de las cuales 3 se han citado por primera vez en el Mediterráneo en general y se han descrito dos nuevas especies para la ciencia.

AGRADECIMIENTOS

Nuestro agradecimiento a Manuel Roca y sus hijos Jesús y Pavel, de Vilanova i la Geltrú, que nos facilitaron los asteroideos y los sedimentos dragados por su embarcación "Joven Mateo"; a Ramón Beneito, de Tarragona y a Vicente Buñuel, de Valls (Tarragona), quienes recolectaron numerosos ejemplares de la familia Janthinidae; a Carmen Salas, del Dpto. de Biología Animal de la Universidad de Málaga, por su ayuda en la determinación de algunos ejemplares de bivalvos; a Anders Warén (Swedish Museum of Natural History, Stockholm) por sus comentarios sobre el género *Bathycrinicola*; a Jesús Méndez, del CACTI (Centro de Apoyo Científico y Tecnológico a la Investigación), de la Universidad de Vigo por la realización de las fotografías al MEB; y especialmente a Emilio Rolán, por sus comentarios, permanente colaboración y ayuda en la digitalización de las láminas.

BIBLIOGRAFÍA

BOUCHET, P. Y WARÉN, A., 1986. Revision of the Northeast Atlantic bathyal and abyssal Aclididae, Eulimidae, Epitoniidae (Mollusca, Gastropoda). *Bollettino Malacologico*, Suppl. 2: 299-576.

BOUCHET, P. Y WARÉN, A., 1993. Revision of the Northeast Atlantic bathyal and abyssal Mesogastropoda. *Bollettino Malacologico*, Suppl. 3: 580-839.

GAGLINI, A., 1992 (1991). Terze spigolature ... monterosatiane. *Argonauta*, 7 (1-6): 125-180.

GERONIMO, I. DI, 1973. *Tiberia octaviana* n. sp. di Pyramidellidae (Gastropoda, Opistobranchia) del Mediterraneo. *Conchiglie*, 9 (11-12): 217-222.

GIRIBET, G. Y PEÑAS, A., 1997. Fauna malacológica del litoral del Garraf (NE de la Península Ibérica). *Iberus*, 15 (1): 41-93.

GIRIBET, G. Y PEÑAS, A., 1998. A new *Epilepton* species (Bivalvia, Montacutidae) from the Western Mediterranean. *Iberus*, 16(2): 117-121.

GOFAS, S., 1982. The genus *Tricolia* in the Eastern Atlantic and the Mediterranean. *The Journal of Molluscan Studies*, 48: 182-213.

GOFAS, S., 1993. Notes on some Ibero-Maroccan and Mediterranean *Tricolia* (Gastropoda, Tricoliidae), with descriptions of new species. *The Journal of Molluscan studies*, 59: 351-361.

HOENSELAAR, H. J. Y MOOLENBEEK, R. G., 1990. First record of *Miralda elegans* (De Folin, 1870) nov. comb. from the Mediterranean Sea (Gastropoda, Pyramidellidae). *Bollettino Malacologico,* 26 (1-4): 65-66.

OLIVERIO, M. Y TRINGALI, L. P., 2001. The types of marine molluscan species described by Monterosato, in the Museo Civico di Zoologia, Roma. General scope of the work, and part 1: the opisthobranch gastropods. *Bollettino Malacologico,* 37 (5-8): 121-142.

PEÑAS, A. Y ROLÁN, E., 1999. Pyramidellidae (Gastropoda, Heterostropha) de la Misión Oceanográfica "Seamount 2". *Iberus,* Suplemento 5: 151-199.

PEÑAS, A. Y ROLÁN, E., 2000. The family Pyramidellidae Gray, 1840 (Mollusca, Gastropoda, Heterostropha) in West Africa. 7. Addenda to the genera *Eulimella* and *Turbonilla,* with a list of the east Atlantic species and synonyms. *Argonauta,* 13 (2): 59-80.

SALAS, C., 1996. Marine Bivalves from off the Southern Iberian Peninsula collected by the Balgim and Fauna 1 expeditions. *Haliotis,* 25: 33-1.

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Nuevas especies de la familia Hydrobiidae (Mollusca, Orthogastropoda) de la Comunidad Valenciana (España)

New species of the family Hydrobiidae (Mollusca, Orthogastropoda) from "Comunidad Valenciana" (Spain)

Emilio ROLÁN* y Alberto MARTÍNEZ-ORTÍ**

Recibido el 27-XI-2002. Aceptado el 10-III-2003

RESUMEN

Se describen cinco nuevas especies de Hydrobiidae encontradas en dos surgencias del municipio de Sueras y en otra más en el de Cabanes, ambos de la provincia de Castellón, Comunidad Valenciana; estas especies se asignan tentativamente a los géneros *Bythiospeum* (1) y *Sardopaladilhia* (4), y se discuten sus asignaciones genéricas.

ABSTRACT

Five new species of the Hydrobiidae found in two springs in the locality of Sueras and one more in Cabanas (both from Castellón province, Comunidad Valenciana, Spain) are described and their relationships are discussed. They are tentatively assigned to the genera *Bythiospeum* (1) and *Sardopaladilhia* (4).

PALABRAS CLAVE: Hydrobiidae, taxonomía, nuevas especies, *Bythiospeum*, *Sardopaladilhia*, Comunidad Valenciana, España.
KEYWORDS: Hydrobiidae, taxonomy, new species, *Bythiospeum*, *Sardopaladilhia*, Comunidad Valenciana, Spain.

INTRODUCCIÓN

Los moluscos de aguas freáticas son poco conocidos debido a sus pequeñas áreas de dispersión, y a las dificultades de obtener muestras de animales vivos y poder estudiar así la anatomía de las partes blandas. Antiguos trabajos como el de BOURGUIGNAT (1863) inician nuestros conocimientos sobre estos grupos.

Mucho más escasa es la información existente sobre estos moluscos en la Península Ibérica, que aparece en trabajos generales como los de HAAS (1929) y BECH (1990), en los que se recogen citas de cuatro especies del género *Moitessieria* Bourguignat, 1863 que, según BOETERS (1988), son dos especies solamente. A éstas, habría que añadir más recientemente, la primera especie de *Paladilhiopsis* para la Península Ibérica descrita por ROLÁN Y RAMOS (1996). En zonas próximas de Francia BOETERS Y GITTENBERGER (1980) describe una nueva *Moitessieria*.

Las relaciones sistemáticas entre estos géneros, todavía insuficientemente estudiadas, han sido comentadas por

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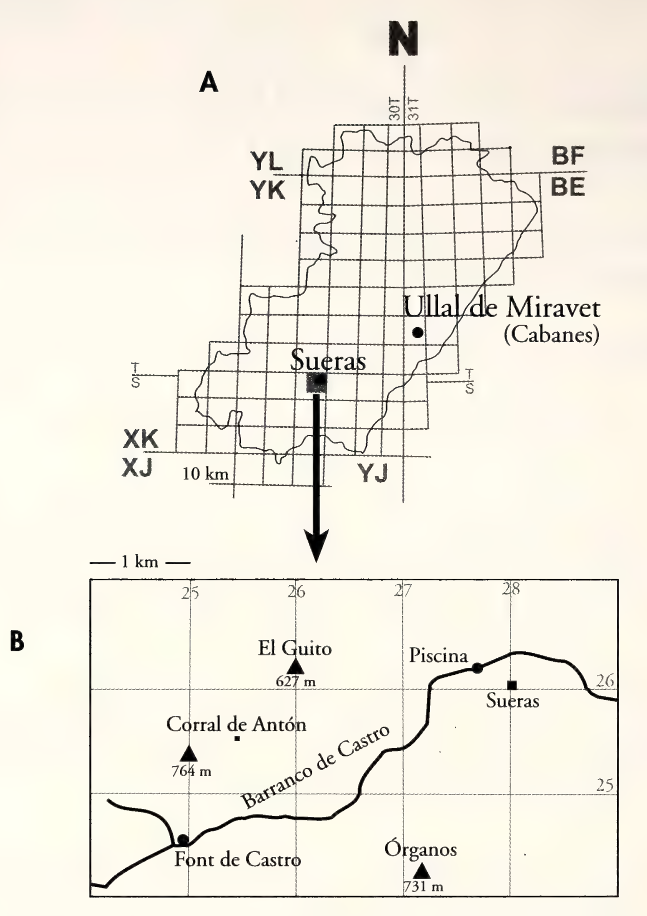


Figura 1. A. Localización geográfica de las surgencias estudiadas en la Provincia de Castellón (España). B. Mapa detallado del área de Sueras (Castellón).
Figure 1. A. Geographical location of the springs studied in the Castellón province (Spain). B. Detailed map of the Sueras area.

BERNASCONI (1984) y BODON Y GIUSTI (1991). Las sinonimias y trabajos que han estudiado la taxonomía y diversas aportaciones en la familia Hidrobiidae han sido recogidas en KABAT y HERSHLER (1993).

Los descubrimientos de nuevas especies e incluso nuevos géneros para moluscos de aguas subterráneas (MANGANELLI, BODON, CIANFANELLI, TALENTI Y GIUSTI, 1998; RAMOS, ARCONADA, ROLÁN Y MORENO, 2000; ARCONADA Y RAMOS, 2001; BERTRAND, 2001; GIRARDI, 2001; ARCONADA Y RAMOS, 2002) se siguen produciendo todavía hoy en día, pese a la dificultad para conseguir la recolección de estos moluscos.

En la Comunidad Valenciana los estudios sobre las fuentes realizados por MORELL (1992) en la provincia de Castellón y TAPIA (1996), en las de Castellón y Valencia, han sido el punto de partida para el estudio de estos diminutos moluscos. Posteriormente los trabajos sobre anatomía y de descripción de nuevas especies de RAMOS *ET AL.* (2000), ARCONADA Y RAMOS (2001) y de ARCONADA Y RAMOS (2002) han contribuido notablemente al conocimiento de la familia Hydrobiidae en esta región.

MATERIAL Y MÉTODOS

Dos surgencias muestreadas se encuentran situadas en el parque natural de la Sierra de Espadán, en la provincia de Castellón, concretamente en el término de Sueras: Font de Castro (UTM: 30SYK249245, 420 m) y Piscina de Sueras (UTM: 30SYK277262, 300 m). Este último nombre hace referencia a que se encuentra a unos 100 m, aguas arriba, de la piscina municipal, a la que suministra agua en verano. La geología de estas localidades corresponde a dolomías, margas, calizas y arcillas con yesos en la primera y sin ellos en la segunda, presentando las dos facies bicarbonatada cálcica (TAPIA, 1996). Otra surgencia está en la localidad de Cabanes: Ullal de Miravet (Castellón) (UTM: 31TBE495446, 144 m) y su geología corresponde a calizas con recubrimientos de arcillas. Para la situación de estas surgencias ver la Figura 1.

El material fue inicialmente recolectado por Gloria Tapia en 1994, y constaba de varias conchas de distintas especies. Con posterioridad, este material se incrementó con nuevas prospecciones realizadas por el segundo autor en 2002.

Para la recolección del material se ha seguido la metodología aplicada por VIAL (1999). Hay que resaltar la necesidad de sumergirse para recoger sedimentos en el interior de la surgencia de la Piscina de Sueras. Los ejemplares fueron separados del sedimento mediante columna de tamices y posterior selección con el esteromicroscopio Leica Wild-M8.

Las vueltas de espira del material estudiado son contadas a partir de un núcleo inicial, según la definición realizada por VERDUIN (1977).

El estudio al MEB fue realizado montando el material en soportes de aluminio con cinta adhesiva Scothch de doble cara y cemento de carbón conductivo, haciendo la metalización con oro. De cada especie fueron estudiadas entre 12 y 35 conchas.

Abreviaturas utilizadas:

AMNH American Museum of Natural History, Nueva York
BMNH The Natural History Museum, Londres
MNCN Museo Nacional de Ciencias Naturales, Madrid
MNHN Museum National d'Histoire Naturelle, Paris
MVHN Museu Valencià d'Història Natural, Valencia
MZB Museu de Zoologia, Barcelona
NNMN Nationaal Natuurhistorich Museum Naturalis, Leiden
CER colección de E. Rolán
c concha
f fragmento

RESULTADOS

"Bythiospeum" gloriae spec. nov. (Figs. 2-8)

Material tipo: Holotipo (Fig. 2) depositado en el MNCN, nº 15.05/46586. Paratipos en las siguientes colecciones: MNCN (2 c), MNHN (1 c), MVHN (8 c, 3 f, nº 805), MZB (1 c, nº 2002-691), NNMN (1 c, nº 94818) y CER (8 c, 11 f).
Localidad típica: Font de Castro, Sueras (Castellón).
Etimología: El nombre específico se dedica a Gloria Tapia, quién estudió los macroinvertebrados de las fuentes de la provincia de Castellón y encontró por primera vez las conchas de las especies estudiadas en este trabajo.

Descripción: Concha (Figs. 2, 3) alargada, ligeramente cónica, hialina, con una altura máxima entre 2,0 y 2,4 mm, ápice romo y un número de vueltas de espira comprendido entre 4 y 5, siendo estas vueltas convexas, aparentemente lisas, con superficie opaca y una sutura profunda. Las líneas de crecimiento son ortoclinas, poco visibles en algunas zonas, apareciendo de vez en cuando alguna línea o

varias muy marcadas, como si fuesen pequeñas costillas. La abertura es redondeada, muy ligeramente oval, con el borde sencillo y fino, pero algo incurvado hacia afuera. Peristoma simple y libre, excepto en su parte interna donde tiene una pequeña zona de contacto con la pared de la última vuelta. Visto lateralmente (Fig. 4) se aprecia que no todo el borde del peristoma se encuentra en el mismo plano, sino que se prolonga ligeramente en la parte en contacto con la última vuelta, mientras por arriba y afuera se ondula, retrasándose ligeramente, con la forma de una mínima escotadura. Hay un ombligo pequeño que queda semioculto por la eversión del peristoma.

La protoconcha (Fig. 5) no presenta un límite claro y apreciable con la teloconcha. El núcleo mide 110-130 µm.

Microescultura: en la protoconcha (Fig. 5), prácticamente no se observa microescultura en la primera media vuelta, pero con posterioridad aparecen pequeñísimas elevaciones en forma de líneas más o menos evidentes que se colocan en posición espiral (Fig. 6), excepto en la parte subsutural, donde se hacen un poco oblicuas. Después de las primeras vueltas (Fig. 7) las líneas se hacen más finas y aparecen en toda la superficie de la vuelta (Fig. 8) que está formada por pequeñísimas elevaciones muy numerosas y discontinuas que se sitúan en sentido espiral.

Dimensiones: El holotipo mide 2,1 x 0,9 mm. Alguna concha alcanza 2,3 mm.

El animal es desconocido.

Discusión: Asignación genérica: La carencia de ejemplares con partes blandas dificulta la asignación genérica. Por su forma corta, ligeramente cónica y el escaso número de vueltas de espira, parece que no debería asignarse al género *Moitessieria* Bourguignat, 1863, que además suele presentar una escultura espiral bastante prominente y frecuentemente formada por cavidades (Bodon y Giusti, 1991).

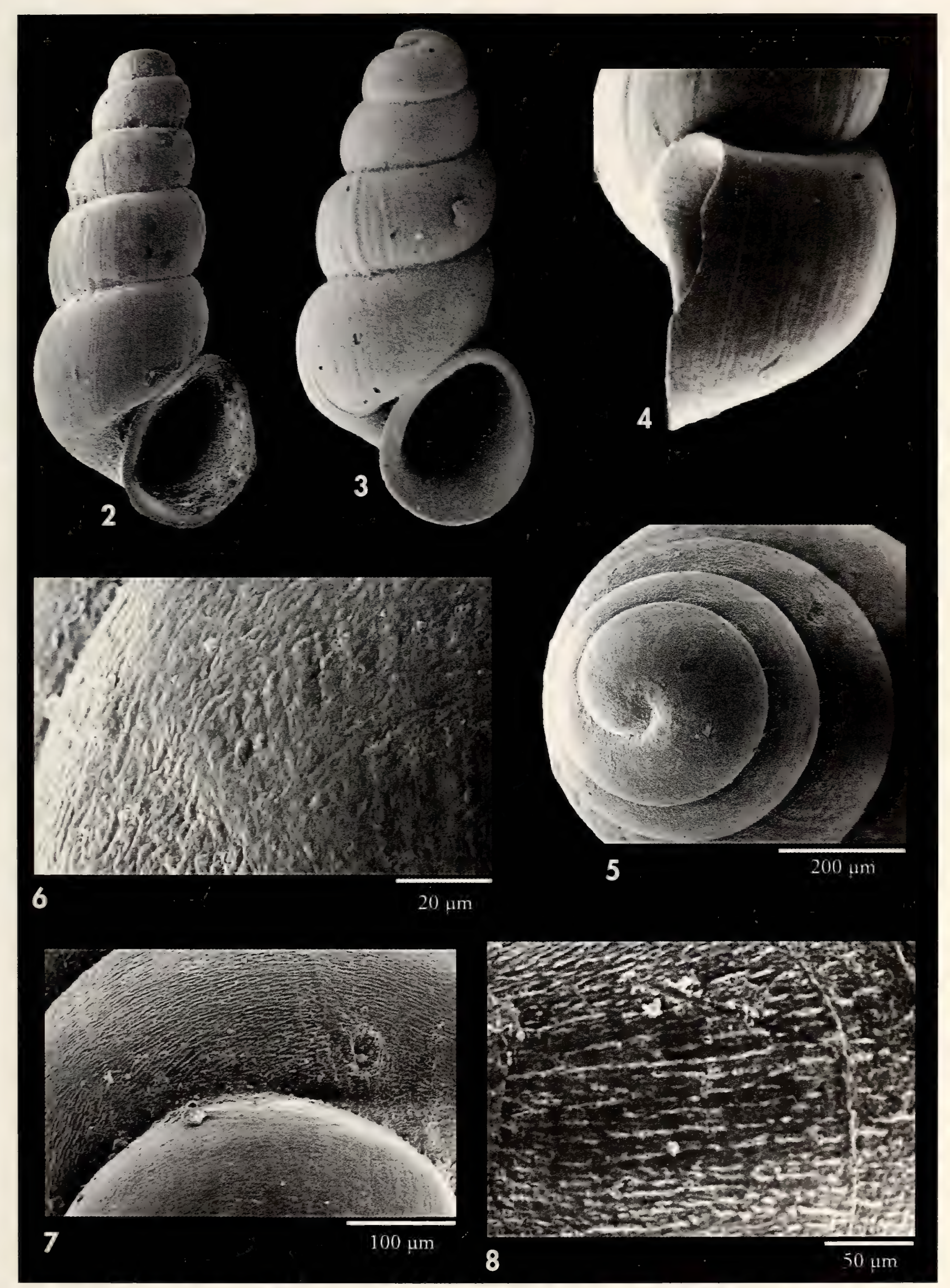
Por su forma, podría pertenecer al género *Paladilhiopsis* Pavlovic, 1913, (especie tipo *P. robiciana* Clessin, 1882), género que ha sufrido diferentes consideraciones: según Schütt (1970) sería un subgénero de *Paladilhia* y para Giusti y Pezzoli (1982) sería un sinónimo de *Bythiospeum*, aunque para Bernasconi (1985) sería un subgénero; sus conchas tienen una espira de crecimiento uniforme y lento; el peristoma está bastante expandido pero el contacto con la vuelta anterior es mayor; el ombligo está casi oculto por el peristoma y, además, la escultura puede ser muy ligera o inexistente (Giusti y Pezzoli, 1980). Giusti y Pezzoli (1982) opinan que el género está mal definido porque su especie típica ha sido extinguida y que es preferible no sea usado. En cualquier caso, las especies de *Paladilhiopsis* pueden o no tener microescultura, pero la última vuelta es más adherente en la parte superior de la abertura a la vuelta anterior, por lo que decidimos descartar su pertenencia a este género.

Algo parecido a ésto también ocurre en *Paladilha* Bourguignat, 1865 (especie tipo *P. pleurotoma* Bourguignat, 1865) ya que las especies de este género, según Boeters y Gittenberger (1990), suelen tener una separación entre el borde de la abertura y la vuelta anterior, y son casi lisas o tienen líneas espirales muy ténues. Y lo mismo se podría decir de *Palaospeum* Boeters, 1999, que también proviene del Sur de Francia y Pirineos.

También la nueva especie presenta cierto parecido en su concha con las del género *Clameia* Boeters y Gittenberger (1990) (especie tipo *C. brooki* Boeters y Gittenberger, 1990) pero ésta también tiene la abertura separada de la vuelta anterior y la estriación espiral suele ser más marcada.

Dadas las diferencias de esta especie con los géneros conocidos de morfología similar, los antecedentes de que en la Península Ibérica nuevos géneros han sido recientemente establecidos, como *Tarraconia*, *Boetersiella*, y otros (ver Ramos *et al.*, 2000, Arconada y Ramos, 2001, 2002), no sería sorprendente que esta nueva especie, junto con *"Paladilhiopsis" septentrionalis* y otras de las descritas a continuación pudiesen pertenecer a nuevos géneros.

Sin embargo, por la carencia de partes blandas en el material estudiado, hemos decidido no crear nuevos taxones supraespecíficos y mantener tentativamente su inclusión en el género *Bythiospeum* Bourguignat, 1882, que se extiende por Suiza,



Figuras 2-8. "*Bythiospeum*" *gloriae* spec. nov. 2: holotipo, 2,1 mm (MNCN); 3: concha, 1,9 mm (CER); 4: detalle de la abertura, paratipo (CER); 5: protoconcha, paratipo (CER); 6: microescultura de la protoconcha; 7: microescultura de las primeras vueltas de la teloconcha; 8: detalle de la microescultura de la teloconcha.

Figures 2-8. "Bythiospeum" gloriae *spec. nov. 2: holotype, 2.1 mm (MNCN); 3: shell, 1.9 mm (CER); 4: detail of the aperture, paratype (CER); 5: protoconch, paratype (CER); 6: microsculpture of the protoconch; 7: microsculpture of the first whorls of the teleoconch; 8: detail of the microsculpture of the teleoconch.*

Alemania y Austria (ZILCH, 1970 y BERNASCONI, 1990), y cuyas conchas parecen presentar una silueta similar, aunque no coincidan en la microescultura.

Diferencias con otras especies: En cuanto a las diferencias con especies ya conocidas de áreas más o menos próximas, y cuya asignación genérica tampoco esté bien definida, hay que establecerlas con *"Paladilhiopsis" septentrionalis* Rolán y Ramos, 1996, conocida sólo por conchas vacías y descrita del norte de la Península Ibérica. Esta especie tiene una microescultura con pequeños hundimientos en la protoconcha y surcos en zigzag en la teloconcha; además, el borde de la abertura está en un plano, se mantiene un poco separado de la vuelta anterior y apenas sufre eversión.

Todas las especies españolas asignadas a los géneros *Alzoniella* Giusti y Bodon, 1984, *Belgrandiella* Wagner, 1927 y *Bythinella* Moquin-Tandon, 1855, presentes en el norte y oeste de la Península Ibérica, carecen de microescultura en la superficie externa de la teloconcha y en cambio tienen depresiones en la protoconcha; su abertura está en un plano, contacta ampliamente con la vuelta anterior, carecen de ombligo y el peristoma no está evertido.

"Moitessieria" juvenisanguis Boeters y Gittenberger, 1980, se encuentra en el oeste del Pirineo francés y se diferencia por tener vueltas de espira más convexas, que crecen más rápidamente, la abertura con ondulaciones más marcadas y, además, presenta una microescultura espiral de la teloconcha formada por cordoncillos.

Sardopaladilhia plagigeyerica Manganelli, Bodon, Cianfanelli, Talenti y Giusti, 1998 tiene el borde externo de la abertura más sobresaliente de la silueta de la concha y prácticamente carece de escultura espiral en la teloconcha mientras en la protoconcha está formada por pequeñas depresiones.

Género *Sardopaladilhia* Manganelli, Bodon, Cianfanelli, Talenti y Giusti, 1998

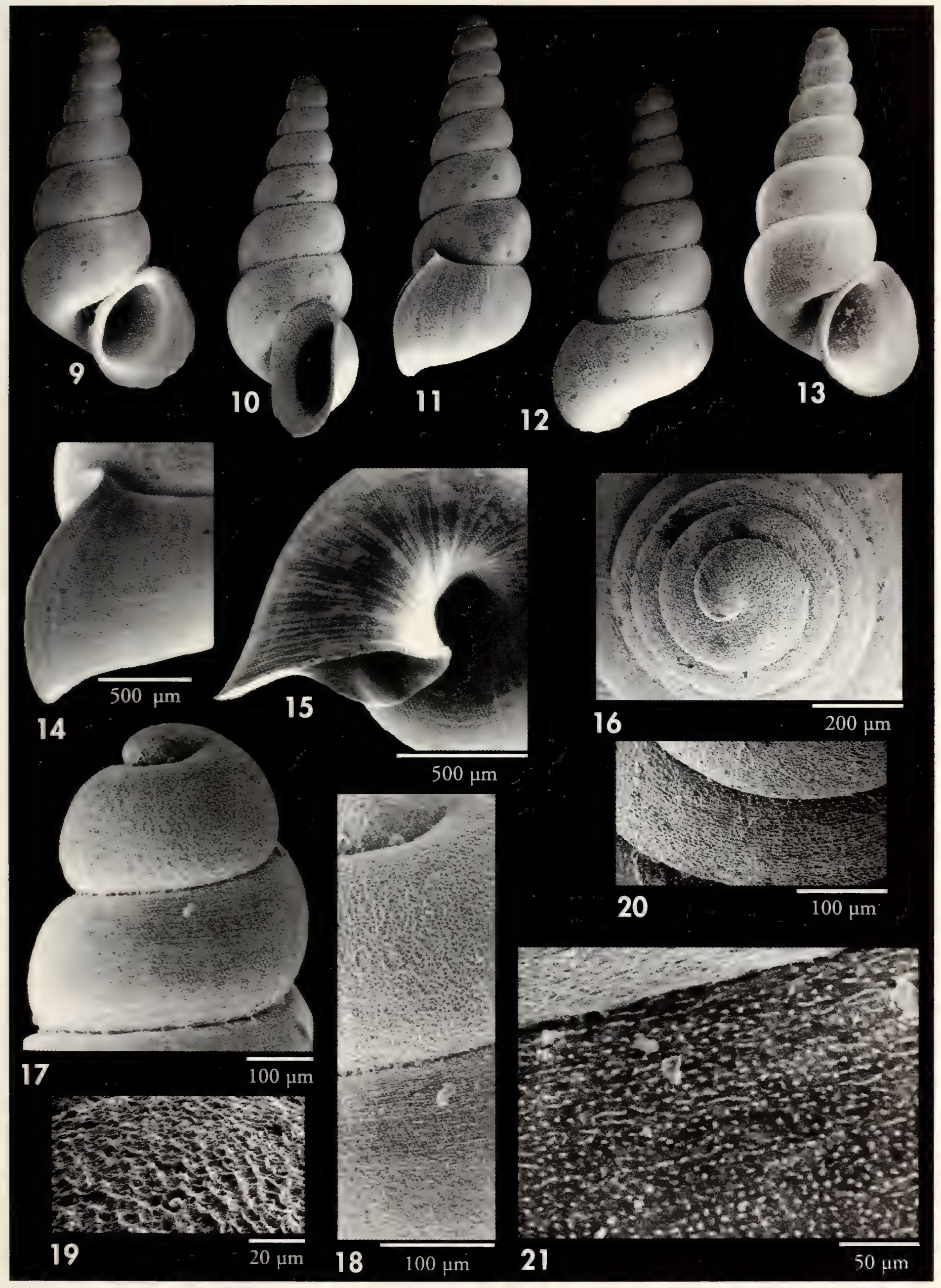
Especie tipo: *S. plagigeyerica* Manganelli, Bodon, Cianfanelli, Talenti y Giusti, 1998 (por original designación y monotipia).

Comentarios: Las características morfológicas de este género son: espira algo elevada; abertura con peristoma sencillo y continuo, algo evertido como en una trompeta; la abertura se adhiere en una zona pequeña a la vuelta anterior y, en este punto, se hace un poco más prominente con respecto al resto del borde; en la parte superior de la abertura, un poco hacia su parte externa, hay una escotadura ligera, que desvía hacia atrás el borde de la misma; el peristoma sobresale de forma clara de la silueta de la teloconcha; escultura espiral de puntos o líneas (poco marcada en la especie tipo); protoconcha con su final mal delimitado con la teloconcha y con escultura poco pronunciada.

Probablemente, *"Moitessieria" juvenisanguis* Boeters y Gittenberger, 1980 pertenece a este género, ya que ni el peristoma, sobresaliente y onduloso, ni la existencia de ombligo, ni la escultura carente de depresiones, parecen ser caracteres que se encuentren en la especie tipo de *Moitessieria*.

Sardopaladilhia marianae spec. nov. (Figs. 9-21)

Material tipo: Holotipo (Fig. 9) depositado en el MNCN, nº 15.05/46587. Paratipos en las siguientes colecciones: MNCN (1 c, Fig. 10), AMNH (1 c, Fig. 11), BMNH (1 c), MNHN (1 c, Fig. 12), MVHN (44 c, nº 806), MZB (2 c, nº 2002-692), NNMN (2 c, nº 94819) y CER (90 c, 56 f, Figs. 16-19).
Otro material estudiado: 16 c, de Cabanes (J. Albesa leg.) (MVHN nº804).
Localidad típica: Piscina de Sueras (Castellón).
Etimología: El nombre específico se dedica a Mariangeles Ramos "Marian", quién inició con nosotros hace años este trabajo pero sus múltiples ocupaciones le impidieron concluirlo.



Figuras 9-21. *Sardopaladilhia marianae* spec. nov. 9: holotipo, 3,4 mm (MNCN); 10: paratipo, 3,4 mm (MNCN); 11: paratipo, 3,4 mm (AMNH); 12: paratipo, 3,2 mm (MNHN); 13: concha, 3,3 mm (CER); 14, 15: detalle de la abertura; 16: protoconcha, paratipo (CER); 17: detalle de la protoconcha; 18, 19: microescultura de la protoconcha; 20, 21: microescultura de la teloconcha.
Figures 9-21. Sardopaladilhia marianae *spec. nov. 9: holotype, 3.4 mm (MNCN); 10: paratype, 3.4 mm (MNCN); 11: paratype, 3.4 mm (AMNH); 12: paratype, 3.2 mm (MNHN); 13: shell, 3.3 mm (CER); 14, 15: detail of the aperture; 16: protoconch, paratype (CER); 17: detail of the protoconch; 18, 19: microsculpture of the protoconch; 20, 21: microsculpture of the teleoconch.*

Descripción: Concha (Figs. 9-13) cónica, hialina, con una máxima dimensión entre 3,0 y 3,7 mm, con ápice romo, y un número de vueltas de espira comprendido entre 6 y 7, siendo estas vueltas convexas, aparentemente lisas, con superficie no brillante y sutura profunda. El crecimiento de la espira es lento pero continuo. Ocasionalmente aparecen vueltas que tienen un abombamiento más acusado que las demás. Líneas de crecimiento ligeramente opistoclinas, finas y numerosas. Ombligo bien definido (Fig. 15). Abertura de forma ligeramente oval, sobresaliendo de la silueta de la concha. El peristoma es sencillo y fino, y está algo evertido, como en una trompeta. La parte superior del peristoma está adherida a la vuelta anterior en un corto sector. En una visión lateral (Figs. 11, 14), este borde no está en un mismo plano en su totalidad y se encuentra algo más prolongado en la zona de contacto con la pared de la última vuelta, mientras, algo más arriba y afuera, el borde está curvado como en una escotadura (Figs. 11, 14), existiendo otra más suave en su parte más interna (Fig. 15).

La protoconcha (Figs. 16, 17) tiene un número de vueltas difícil de precisar porque no existe un límite claro con la teloconcha. El núcleo mide 135-140 µm, y tiene una microescultura (Fig. 18) formada por concavidades irregulares con bordes elevados; esta escultura se cambia a continuación (Fig. 19) por otra que tiene pequeñas depresiones rodeadas por zonas elevadas irregulares. Poco después de algo más de una vuelta desde el núcleo, esta escultura se cambia por otra en la que aparecen finísimos cordoncillos espirales formados por la fusión de tubérculos (Figs. 18, 20). Una vuelta después, aproximadamente, la escultura ha cambiado ligeramente, persistiendo una estriación espiral formada por tubérculos fusionados, que forman cortos trazos, pero con una densidad inferior a la anterior (Fig. 21).

Dimensiones: el holotipo mide 3,4 x 1,7 mm. Una buena parte de las conchas estudiadas alcanzan estas dimensiones, e incluso alguna llegó a medir 3,76 mm de altura siendo otras algo más pequeñas.

El animal es desconocido.

Discusión: La asignación genérica de esta especie se basa en la gran similaridad de la concha con la de *S. plagigeyerica* (especie tipo del género) por lo que, incluso con la carencia de datos anatómicos, la relación con el género *Sardopaladilhia* nos parece extremadamente probable, y creemos justificada la asignación categórica a este género.

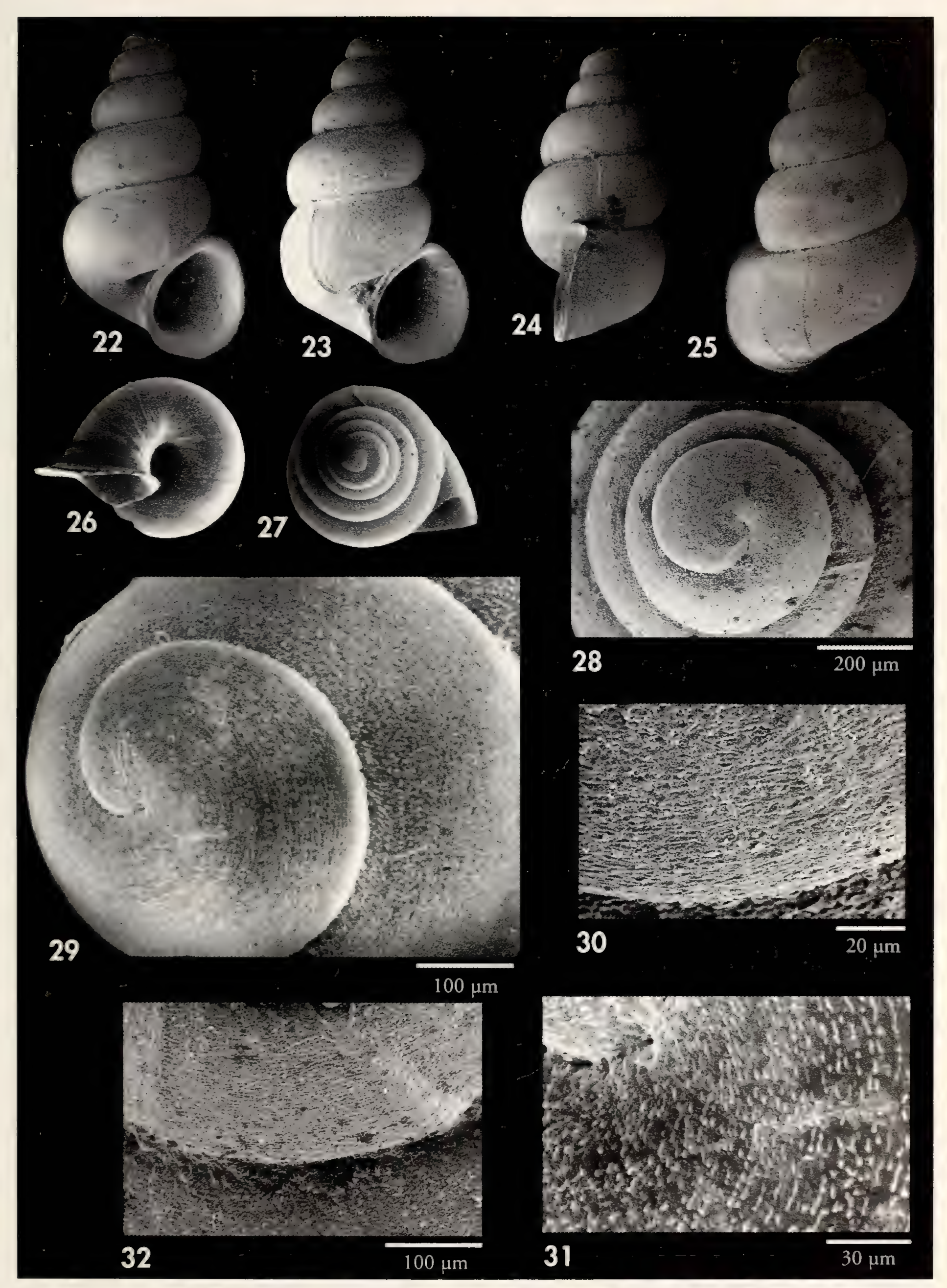
Las diferencias específicas con *S. plagigeyerica* se basan en que esta especie tiene una concha un poco menos alargada, la microescultura de la protoconcha tiene depresiones mucho menos marcadas y la microescultura de la teloconcha es mucho menos evidente (BODON Y GIUSTI, 1991).

"Moitessieria" juvenisanguis tiene una forma similar, pero su abertura es menos evertida mientras la escotadura superior de la abertura es mayor; tiene una diferente microescultura de la protoconcha (líneas de tubérculos en vez de depresiones) y de la teloconcha (filetes espirales bien diferenciados).

Por su mayor tamaño y su forma más alargada y cónica se diferencia fácilmente de *"Paladilhiopsis" septentrionalis* Rolán y Ramos, 1996, y de *"Bythiospeum" gloriae* spec. nov.

"Sardopaladilhia" buccina spec. nov. (Figs. 22-32)

Material tipo: Holotipo (Fig. 22) depositado en el MNCN, nº 15.05/46588. Paratipos en las siguientes colecciones: MNCN (10 c), AMNH (1 c, Fig. 23), BMNH (1 c), MNHN (1 c, Fig. 24), MVHN (156 c, nº 807), MZB (5 c, 2002-693), NNMN (5 c, nº 94820) y CER (84 c, 10 f, Fig. 25).
Otro material estudiado: Más de 500 conchas y otros tantos fragmentos de la localidad tipo.
Localidad típica: Font de Castro, Sueras (Castellón).
Etimología: El nombre específico proviene de la palabra latina *buccina* que significa trompeta, haciendo referencia a la forma de la concha y a la abertura con el peristoma evertido.



Figuras 22-32. "*Sardopaladilhia*" *buccina* spec. nov. 22: holotipo, 2,4 mm (MNCN); 23: paratipo, 2,4 mm (AMNH); 24: paratipo, 2,2 mm (MNHN); 25: paratipo, 2,5 mm (CER), 26: visión inferior (MNCN); 27: visión superior (MNCN); 28: protoconcha, paratipo (CER); 29: detalle de la protoconcha (CER); 30, 31: microescultura de la protoconcha; 32: microescultura de la teloconcha.

Figures 22-32. "Sardopaladilhia" buccina *spec. nov. 22: holotype, 2.4 mm (MNCN); 23: paratype, 2.4 mm (AMNH); 24: paratype, 2.2 mm (MNHN); 25: paratype, 2.5 mm (CER), 26: visión inferior (MNCN); 27: apical vision (MNCN); 28: protoconch, paratype (CER); 29: detail of the protoconch (CER); 30, 31: microsculpture of the protoconch; 32: microsculpture of the teleoconch.*

Descripción: Concha (Figs. 22-25) cónica, hialina, con una máxima dimensión entre 2,1 y 2,6 mm de altura y 1,53 mm de diámetro, con ápice romo, y un número de vueltas de espira de 4 a 4 $^{3}/_{4}$, siendo estas vueltas muy convexas, aparentemente lisas, con superficie no brillante y sutura profunda. En ocasiones se observan pequeñas irregularidades o deformaciones de las vueltas, que modifican la regularidad del perfil de la concha. Líneas de crecimiento finas, poco manifiestas y ligeramente opistoclinas. La abertura es redondeada, ligeramente oval, con el borde sencillo y fino, pero algo girado hacia afuera como en una trompeta, y estando su parte superior e interna en contacto con la vuelta anterior, únicamente en un corto sector. En una visión lateral (Figs. 24, 26) se aprecia que no todo el borde labial se encuentra en el mismo plano, sino que se prolonga ligeramente en la parte en contacto con la vuelta anterior (Fig. 26), mientras por arriba hacia la parte externa de la abertura (Figs. 24, 26, 27) se ondula, formando una pequeña escotadura, que se retrasa ligeramente. Hay un ombligo apreciable que, en una visión anterior, queda parcialmente oculto por la eversión de la abertura.

La protoconcha (Fig. 28) tiene un límite no bien apreciable con la teloconcha. El núcleo mide entre 140-150 µm.

Microescultura: La protoconcha (Figs. 29, 31) presenta una escultura formada, en su comienzo, por líneas que se colocan espiralmente en forma de espigas, transformándose a continuación en tubérculos que se agrupan formando líneas espirales, y que, en la parte media e inferior de la vuelta, se fusionan (Fig. 30) dando lugar a estructuras espiralmente alargadas. En la teloconcha (Fig. 32), la microescultura está formada por tubérculos que adoptan una cierta alineación espiral y que, en muchos lugares, se encuentran fusionados con otros próximos formando líneas irregulares y produciendo dibujos arabescos.

El holotipo mide 2,4 x 1,1 mm. Alguna concha puede ser ligeramente más grande.

El animal es desconocido.

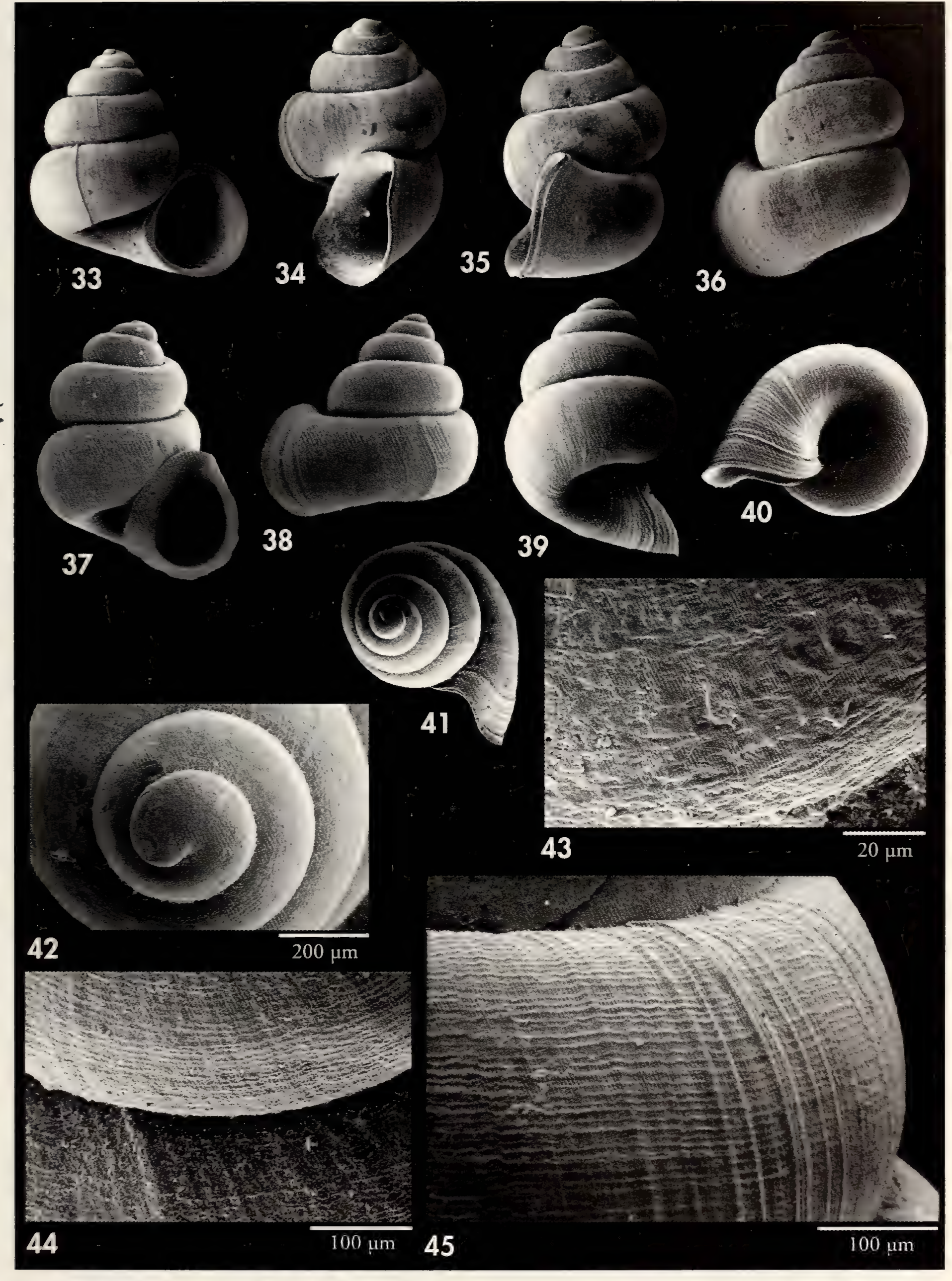
Discusión: La asignación genérica está basada en la semejanza de algunos caracteres de de la concha de esta especie con la de *S. plagigeyerica*, la especie tipo del género que, sin embargo, tiene la abertura menos evertida en su borde y, en cambio, sobresale más del perfil de la concha. Además tiene microescultura con depresiones en la protoconcha y, en la teloconcha, la escultura es menos manifiesta. Por estas diferencias, esta asignación no puede ser más que tentativa.

De *Sardopaladilhia marianae* spec. nov. se diferencia porque esta especie es más grande, más cónica, con el peristoma más sobresaliente del perfil de la concha y la microescultura de la protoconcha está formada depresiones mientras que la de la teloconcha tiene tubérculos en vez de pequeños trazos.

Las diferencias con otras especies conocidas de la Península Ibérica hay que establecerlas con *"Paladilhiopsis" septentrionalis*, que tiene menos escultura, formada por líneas en zigzag, y el peristoma se separa de la vuelta anterior manteniéndose todo el borde en un plano.

"Moitessieria" juvenisanguis Boeters y Gittenberger, 1980, tiene una silueta más alargada, la escotadura de la abertura es más pronunciada, la abertura sobresale más de la silueta de la concha y tiene una microescultura de la protoconcha formada por líneas de tubérculos mientras la de la teloconcha está formada por cordoncillos bien definidos.

"Bythiospeum" gloriae spec. nov., que vive en simpatría en la localidad típica, se diferencia porque en su espira las vueltas tienen menor velocidad de crecimiento, y por lo tanto su forma es más esbelta por ser menos ancha en la última vuelta; además la abertura es menos sobresaliente, y su escultura es más atenuada.



Figuras. 33-45. "*Sardopaladilhia*" *distorta* spec. nov. 33: holotipo, 2,0 mm (MNCN); 34: paratipo, 2,3 mm (AMNH); 35: paratipo, 1,9 mm (MNHN); 36: paratipo, 2,0 mm (CER); 37-40: paratipos, 2,1, 2,1, 1,8 y 2,0 mm (MNCN); 41: paratipo, 1,9 mm (CER); 42: protoconcha, paratipo (CER); 43: microescultura de la protoconcha; 44, 45: microescultura de la teloconcha.

Figures. 33-45. "Sardopaladilhia" distorta *spec. nov. 33: holotype, 2.0 mm (MNCN); 34: paratype, 2.3 mm (AMNH); 35: paratype, 1.9 mm (MNHN); 36: paratype, 2.0 mm (CER); 37-40: paratypes, 2.1, 2.1, 1.8 y 2.0 mm (MNCN); 41: paratype, 1.9 mm (CER); 42: protoconch of a paratype (CER); 43: microsculpture of the protoconch; 44, 45: microsculpture of the teleoconch.*

"Sardopaladilhia" distorta spec. nov. (Figs. 33-45)

Material tipo: Holotipo (Fig. 33) depositado en el MNCN, nº 15.05/46589. Paratipos en las siguientes colecciones: MNCN (4 c, Figs. 37-40), AMNH (1 c, Fig. 34), BMNH (1 c), MNHN (1 c, Fig. 35), MVHN (7 c, nº 808), MZB (1 c, nº 2002-694), NNHM (1 c, nº 94821) y CER (44 c, Figs. 36, 41).
Otro material examinado: 17 f, de la localidad típica.
Localidad típica: Piscina de Sueras (Castellón).
Etimología: El nombre específico hace alusión a la forma de la concha con desviaciones del eje de la espira que le da un aspecto contrahecho.

Descripción: Concha (Figs. 33-41) oval-cónica, hialina, con una máxima dimensión entre 1,8 y 2,4 mm, con ápice romo, y un número de vueltas de espira de 4-4 $^{1}/_{2}$, siendo estas vueltas muy convexas, con superficie no brillante y sutura profunda. Existen frecuentes irregularidades o deformaciones de las vueltas, que dan la impresión de no adaptarse exactamente al eje de la concha, o variar su eje en momentos distintos. Sin escultura aparente, excepto líneas de crecimiento que son finas y numerosas, algo sinuosas, especialmente hacia la base; parecen ortoclinas o ligeramente prosoclinas, en especial al final de la espira cuando la vuelta está distorsionada. La última vuelta de espira se proyecta hacia afuera y un poco hacia arriba, sobresaliendo notablemente de la silueta de la concha (Fig. 39, 41). La abertura es redondeada, ligeramente piriforme, con el peristoma sencillo y fino, pero algo evertido hacia fuera, como en una trompeta, y manteniendo un espacio muy corto de su parte interna y superior en contacto con la vuelta anterior. En una visión lateral (Figs. 34, 35) el borde del peristoma se muestra ondulado, con una depresión en la parte superior y otra en la más interna. Ombligo abierto y profundo.

La protoconcha (Figs. 41, 42) no presenta una clara separación con la teloconcha, aunque se aprecia, en algunas ocasiones, un cambio en la microescultura después de algo más de una vuelta. El núcleo mide unas 130 µm.

Microescultura: en la protoconcha, la escultura está formada por un dibujo irregular en forma de pequeñas excavaciones y lineas espirales, apenas insinuadas, dispuestas ligeramente en sentido espiral (Fig. 43), apareciendo al comienzo de la teloconcha cordoncillos espirales finos que recorren toda la concha haciéndose más evidentes (Figs. 44, 45) y que están cruzados por numerosas estrías de crecimiento.

Dimensiones: el holotipo mide 2,0 x 1,7 mm. Algunas conchas pueden alcanzar hasta 2,4 mm y 1,8 de diámetro.

El animal es desconocido.

Discusión: La posición genérica de esta especie en *Sardopaladilha*, es tentativa, y está basada en la abertura con el borde del peristoma evertido y con ondulaciones semejantes a las que aparecen en las especies antes descritas, así como una microescultura más o menos similar en protoconcha y teloconcha.

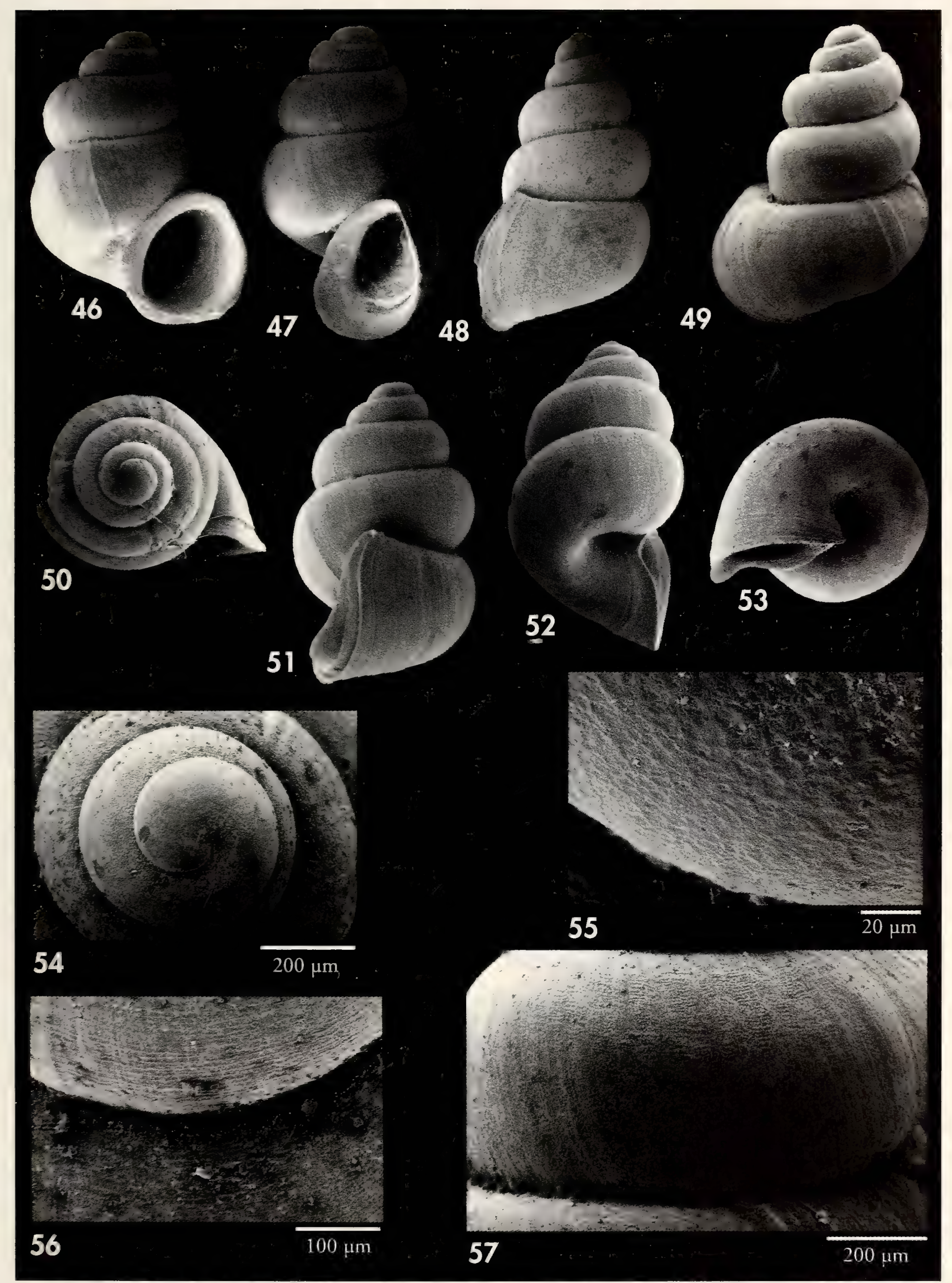
Otros géneros que podrían haber sido utilizados pero fueron descartados para esta especie fueron los siguientes:

• *Bythiospeum* Bourguignat, 1882 (ver anteriormente) tiene conchas con espira regular y la abertura carece de una gran eversión.

• *Paladilhiopsis* Pavlovic, 1913. (ver anteriormente) ocurre lo mismo que con el género anterior.

• *Iglica* Wagner, 1927 (especie tipo *I. gratulabunda* Wagner, 1927) no parece el adecuado porque (según Giusti y Pezzoli, 1980) tiene forma alargada, sutura no profunda, ombligo apenas visible, peristoma no expandido y apenas sinuoso, sin microescultura externa.

• *Moitessieria* Bourguignat, 1863 (especie tipo: *M. simoniana* Saint-Simon, 1848) tiene la concha muy uniformemente alargada, la abertura está adherida en parte a la vuelta anterior, no hay ombligo evidente y el peristoma no está o está muy ligeramente evertido; su microescultura está formada por perforaciones espirales aunque, a veces, tiene cordoncillos. Según Bernasconi (1984)



Figs. 46-57. "*Sardopaladilhia*" *subdistorta* spec. nov. 46: holotipo, 1,8 mm (MNCN); 47: paratipo, 2,1 mm (AMNH); 48: paratipo, 2,3 mm (BMNH); 49: paratipo, 2,05 mm (CER); 50: paratipo, 2,0 (CER); 51, 52: paratipos, 2,0 y 2,2 mm (MNCN); 53: paratipo, 1,9 mm (CER); 54: protoconcha (CER); 55: detalle de la microescultura de la protoconcha; 56, 57: microescultura de la teloconcha.
Figs. 46-57. "Sardopaladilhia" subdistorta *spec. nov. 46: holotype, 1.8 mm (MNCN); 47: paratype, 2.1 mm (AMNH); 48: paratype, 2.3 mm (BMNH); 49: paratype, 2.05 mm (CER); 50: paratype, 2.0 (CER); 51, 52: paratypes, 2.0 y 2.2 mm (MNCN); 53: paratype, 1.9 mm (CER); 54: protoconch (CER); 55: detail of the microsculpture of the protoconch; 56, 57: microsculpture of the teleoconch.*

y BODON Y GIUSTI (1991) *Spiralix* Boeters, 1972 sería un sinónimo.

• *Clameia* Boeters y Gittenberger, 1990 (especie tipo *C. brooki* Boeters y Gittenberger, 1990) tiene una concha uniformemente alargada, el peristoma está evertido como en una trompeta, pero está separado de la vuelta anterior. La microescultura está formada por líneas espirales formadas por segmentos oblicuos conectados.

• *Paladilhia* Bourguignat, 1865 (especie tipo *P. pleurotoma* Bourguignat, 1865) tiene la abertura piriforme con el borde interno del peristoma rectilíneo y en posición oblicua al eje de la concha, el ombligo está casi cerrado por el peristoma y la microescultura no existe o es casi inexistente (LOCARD, 1893, BODON Y GIUSTI, 1991).

• *Lartetia* Bourguignat, 1869 (especie tipo *L. belgrandi* (Bourguignat, 1869) tiene la abertura bastante adherida a la vuelta anterior y el ombligo aparece aplastado.

Por las razones explicadas y no considerando su posible pertenencia a los géneros mencionados, decidimos su inclusión provisionalmente en *Sardopaladilhia* que parece reunir más caracteres similares, aún teniendo en cuenta ciertas diferencias que presenta *"S". distorta*, como son las desviaciones del eje de la espira, la dirección hacia arriba del final de la última vuelta y la microescultura que es un poco diferente de la de la especie típica.

La diferenciación de *"S". distorta* de la especie tipo del género, *S. plagigeyerica*, se basa en que esta última especie tiene una espira con crecimiento más lento, con menor tendencia a la distorsión, la última vuelta no tiende a elevarse y la microescultura de la teloconcha es muy poco aparente.

Con las especies consideradas congenéricas y que se han descrito anteriormente, se diferencia por su desviación del eje de la concha y elevación final de la última vuelta.

"Sardopaladilhia" subdistorta spec. nov. (Figs. 46-57)

Material tipo: Holotipo (Fig. 46) depositado en el MNCN, nº 15.05/46590. Paratipos en las siguientes colecciones: MNCN (4 c, Figs. 51, 52), AMNH (1 c, Fig. 47), BMNH (1 c, Fig. 48), MNHN (1 c), MVHN (64 c, nº 809), MZB (5 c, nº 2002-695), NNMN (5 c, nº 94822) y CER (133 c, 6 f, Figs. 49, 50, 53).
Otro material examinado: más de 100 c, y de 250 fragmentos, de la localidad típica.
Localidad típica: Font de Castro, Sueras (Castellón).
Etimología: El nombre específico hace alusión a la forma de la concha, similar a *S. distorta*, pero con desviaciones menores y menor aspecto de concha contrahecha.

Descripción: Concha (Figs. 46-53) oval cónica, hialina, con una máxima dimensión entre 1,8 y 2,3 mm, con ápice romo, y un número de vueltas de espira comprendido entre 3 $^1/_2$ y 4 $^1/_2$, siendo estas vueltas muy convexas, con superficie no brillante y sutura profunda. Las vueltas siguen el mismo eje de la concha, aunque no son extremadamente regulares, y a veces parece que se separan ligeramente de este eje. No hay una escultura aparente, excepto líneas de crecimiento que son finas y numerosas, prosoclinas y algo sinuosas, especialmente hacia la base. La última vuelta de espira es prominente, sobresaliendo un poco de la silueta de la concha. La abertura es redondeada, ligeramente oval, con el peristoma sencillo y fino, y ligeramente evertido hacia afuera; hay un espacio muy corto de su parte interna y superior en contacto con la vuelta anterior. En una visión lateral (Fig. 51) el borde del peristoma se muestra un poco ondulado, con una depresión en la parte superior y otra en la más interna (Fig. 52). Ombligo abierto y profundo.

La protoconcha (Fig. 54) tiene poco preciso el punto de separación con la teloconcha aunque, en algunas ocasiones, se puede apreciar un cambio en la

microescultura un poco después de la primera vuelta de espira. El núcleo mide alrededor de 157 µm.

Microescultura: en la protoconcha, la escultura está formada por un dibujo irregular en forma de pequeñas escavaciones, apenas insinuadas, y diminutos trazos espirales (Fig. 55); un poco más adelante aparecen cordoncillos espirales finos que recorren toda la concha haciéndose más evidentes (Figs. 56, 57) aunque a veces se interrumpen al ser cruzados por las estrías de crecimiento.

Dimensiones: el holotipo mide 1,8 x 1,3 mm. Otras conchas llegan a medir 2,3 mm de altura y 1,61 de diámetro.

El animal es desconocido.

Discusión: La especie más próxima a "S". *subdistorta* spec. nov. es "S". *distorta* spec. nov., pero se diferencia porque esta última especie es proporcionalmente más ancha, sus primeras vueltas de espira son más regulares y menos elevadas, lo que hace que el ángulo de la espira, medido en las tres primeras vueltas sea bastante mayor (88,86º para "S". *distorta* vs. 71,75º para "S". *subdistorta*, n = 20); en las primeras vueltas de espira hay una mayor distorsión del eje de las vueltas en "S". *subdistorta*, mientras que el final de la última vuelta tiende a separarse más del eje de la concha en "S". *distorta*. Estas diferencias morfológicas son bastante claras y constantes en el examen comparativo realizado en numerosos ejemplares de las dos especies. Por este motivo, y pese a la evidente relación entre ambos morfos, creemos que sus diferencias justifican la separación específica.

Para la comparación de "S". *subdistorta* con otras especies pueden servir los mismos comentarios que se han realizado en la discusión de "S". *distorta*.

AGRADECIMIENTOS

A Gloria Tapia quién remitió el primer material para su estudio. A Jesús Méndez de los Servicios Generales de Apoyo a la Investigación de la Universidad de Vigo por las fotografías realizadas al MEB. También a Joaquín Albesa, quién nos proporcionó material de Cabanes, y Sergio Montagut, por su colaboriación en los distintos muestreos realizados, aportando material de buceo y velando por nuestra integridad física dada la dificultad del acceso a los sedimentos. Finalmente, a Folco Giusti y a otro revisor anónimo por sus sugerencias y correcciones al manuscrito.

El presente trabajo ha sido subvencionado parcialmente por el Proyecto Atlas de Invertebrados.

BIBLIOGRAFÍA

ARCONADA, B. Y RAMOS, M. A., 2001. New data on Hydrobiidae systematics: two new genera from the Iberian Peninsula. *Journal of Natural History*, 35: 949-984.

ARCONADA B. Y RAMOS, M. A., 2002. *Spathogyna*, A new genus for *Valvata (?Tropidina) fezi* Altimira, 1960 from eastern Spain: Another case of Pseudohermaphroditism in the Hydrobiidae (Gastropoda). *Journal of Molluscan Studies* (200) 68: 319-327.

BECH, M., 1990. *Fauna malacològica de Catalunya. Mol.luscs terrestres i d'aigua dolça*. Treballs de la Institució Catalana d'Història Natural, 12: 1-229.

BERNASCONI, R., 1984. Découverte du genre *Moitessieria* Bgt. (Mollusca Gastropoda Hydrobiidae dans le Dijonnais (Côte d'Or). *Revue Suisse de Zoologie*, 91 (3): 687-697.

BERNASCONI, R., 1985. *Bythiospeum* (Mollusca Gasteropoda Hydrobidae) de France, nouveaux ou faisant l'object d'une révision. *Revue Suisse de Zoologie*, 92 (2): 333-349.

BERNASCONI, R., 1990. *Revision of the genus Bythiospeum (Mollusca Prosobranchia Hydrobiidae) of France, Switzerland and Germany*. Ed. Bernasconi, Münchenbuchsee, 79 pp.

BERTRAND, A., 2001. *Moitessieria fontsaintei* sp. nov. (Gastropoda: Prosobranchia: Moitessieriidae) des Pyrénées ariégoises. *Documents Malacologiques*, 2: 39-41.

BODON, M. Y GIUSTI, F., 1991. The genus *Moitessieria* in the island of Sardinia and in Italy. New data on the systematics of *Moitessieria* and *Paladilhia* (Prosobranchia: Hydrobiidae) (Studies on the Sardinian and Corsican malacofauna, IX). *Malacologia*, 33 (1-2): 1-30.

BOETERS, H. D., 1988. Moitessieriidae und Hydrobiidae in Spanien und Portugal (Gastropoda: Prosobranchia). *Archiv Molluskenkunde*, 118 (4/6): 181-261, 4 láms.

BOETERS, H. D., 1998. *Mollusca: Gastropoda: Superfamilie Rissooidea*. Gustav Fischer, Stuttgart, 76 pp.

BOETERS, H. D. Y GITTENBERGER, E., 1980. Unbekannte westeuropäische Prosobranchia, 4. *Basteria*, 44: 65-68.

BOETERS, H. D. Y GITTENBERGER, E., 1990. Once more on the Moitessieriidae (Gastropoda Prosobranchia) with the description of *Clameia brooki* gen. et spec. nov. *Basteria*, 54: 123-129.

BOURGUIGNAT, M. J. R., 1863. *Monographie du nouveau genre Français Moitessieria*. F. Savy. Paris. 18 pp.

GIUSTI, F. Y PEZZOLI, E., 1980. *Guide per il riconoscimento delle specie animali delle acque interne italiane.8. Gasteropodi, 2 (Gastropoda: Prosobranchia: Hydrobioidea, Pyrguloidea)*. Consiglio Nazionale delle Richerche. Siena. 67 pp.

GIUSTI, F. Y PEZZOLI, E., 1982. Notes on the small Hydrobioidea in Italian subterranean waters: catalogue, biogeography and some systematic problems. *Malacologia*, 22 (1-2): 463-468.

GIRARDI, H., 2001. *Moitessieria wienini* sp. nov. Des eaux de l'aquifère de la montagne de la Selette (France, Hérault) (Mollusca: Gastropoda: Moitessieriidae): *Documents Malacologiques*, 2: 31-38.

HAAS, F., 1929. Fauna malacológica terrestre y de agua dulce de Cataluña. *Treballs de la Institució Catalana d'Història Natural*, 5: 1-491, 55 lám. (facsimil editado en 1991)

KABAT, A. R. Y HERSHLER, R., 1993. *The Prosobranch Snail Family Hydrobiidae (Gastropoda: Rissooidea): Review of Classification and Supraspecific Taxa*. Smithsonian Institution Press. Washington. 94 pp.

LOCARD, A., 1893. *Les coquilles des eaux douces et saumâtres de France*. Bailliére et Fils, Paris. 327 pp.

MANGANELLI, G., BODON, M., CIANFANELLI, S., TALENTI, E. Y GIUSTI, F., 1998. New hydrobiids from subterranean waters of eastern Sardinia, Italy (Gastropoda Prosobranchia: Hydrobiidae). *Basteria*, 62: 43-67.

MORELL, I., 1992. *Los manantiales de la provincia de Castellón*. Diputación de Castelló. 307 pp.

RAMOS, M. A., ARCONADA, B., ROLÁN, E. Y MORENO, D., 2000. A new genus and a new species of Hydrobiid snail (Mollusca: Gastropoda: Hydrobiidae) from eastern Spain. *Malacologia*, 42 (1-2): 75-101.

ROLAN E. Y RAMOS, M., 1996. Una nueva especie de Hydrobiidae (Mollusca, Prosobranchia) del norte de la Península Ibérica. *Iberus*, 13 (2): 119-127.

SCHÜTT, H., 1970. Neue For men höhlenbewohnender Hydrobiiden des Balkan und ihre Beziehungen zu Paladilhiopsis Pavlovic, 1913. *Archiv für Molluskenkunde*, 100 (5-6): 305-317, pls. 14-15.

TAPIA, G., 1996. *La fauna de invertebrados de las Fuentes de Valencia y Castellón y su relación con las propiedades fisico-químicas del agua*. Tesis doctoral (inédita). Universitat de Valencia, 265 pp.

VERDUIN, A., 1977. On a remarkable dimorphism of the apices in many groups of sympatric, closely related marine gastropod species. *Basteria*, 41: 91-95.

VIAL, E., 1999. Recolté des Hydrobiidae souterrains et des sources interet et methods. *Vertigo*, 7 (1997): 31-34.

WILKE, T., DAVIS, G. M., FALNIOWSKI, A., GIUSTI, F., BODON, M. Y SZAROWSKA, M., 2001. Molecular systematics of Hydrobiidae (Mollusca: Gastropoda: Rissooidea): testing monophyly and phylogenetic relationships. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 151: 1-21.

ZILCH, A. 1970. Die Typen und Typoide des Naturmuseums Senckenberg. Mollusca Hydrobiidae (1): *Bythiospeum* Bourguignat. *Archiv Molluskenkunde*, 100 (5-6): 319-346.

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The deep-water Indo-Pacific radiation of *Fusinus* (*Chryseofusus* subgen. nov.) (Gastropoda: Fasciolariidae)

La radiación Indo-Pacífica de aguas profundas del género *Fusinus* (*Chryseofusus* subgen. nov.) (Gastropoda: Fasciolariidae)

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Recibido el 2-XII-2002. Aceptado el 11-III-2003

ABSTRACT

A number of fusinids from the Indo-Pacific deep-water fauna are studied to get more insight in the distribution and variability. The subgenus *Chryseofusus* (Gastropoda: Fasciolariidae: *Fusinus* Rafinesque, 1815) is described as new to accommodate a number of species sharing conchological characteristics different from typical *Fusinus*. Their separation from *Fusinus s.s.* is based on differences in axial sculpture (usually absent on body whorl), spiral sculpture (weak, close-set, regular, crossed by distinct growth lines), shape (shorter spire, shorter siphonal canal, less convex whorls with subsutural concavity, less constricted suture) and parietal callus (inner lip smooth, parietal wall covered with an extended, adherent thin layer of callus).

Fusinus (Chryseofusus) bradneri (Drivas and Jay, 1990), *F. (C.) chrysodomoides* (Schepman, 1911), *F. (C.) graciliformis* (Sowerby, 1880), *F. (C.) hyphalus* M. Smith, 1940, *F. (C.) jurgeni* Hadorn and Fraussen, 2002, *F. (C.) kazdailisi* Fraussen and Hadorn, 2000 and *F. (C.) subangulatus* (von Martens, 1901) are briefly described and their taxonomic placement in the new subgenus is discussed.

To avoid further taxonomic complications, a lectotype is designated for the correct *F. (C.) chrysodomoides*.

F. (C.) acherusius (west Madagascar, Mozambique Channel, 1475-1530 m), *F. (C.) alisae* (north New Caledonia, 444-452 m), *F. (C.) artutus* (Philippines, Bohol, deep water), *F. (C.) cadus* (south New Caledonia, 460-470 m), *F. (C.) dapsilis* (Vietnam, deep water), *F. (C.) riscus* (New Caledonia, Norfolk Ridge, 394-401 m), *F. (C.) scissus* (south New Caledonia, 535 m), *F. (C.) wareni* (New Caledonia, 480 m), and *F. (C.) westralis* (northwest Australia, off Port Hedland, 450 m) are described as new to science.

RESUMEN

Se estudia un grupo de fusínidos de la fauna de aguas profundas del Indo-Pacífico, con el fin de profundizar en su distribución y variabilidad. Se describe el subgénero *Chryseofusus* (Gastropoda: Fasciolariidae: *Fusinus* Rafinesque, 1815) para incluir a un número de especies que comparten caracteres conquiológicos distintos de los típicos *Fusinus*. Su separación de *Fusinus s.s.* se basa en diferencias en la escultura axial (normalmente ausente en la espira del cuerpo), escultura espiral (debil, compacta, regular, atravesada por claras líneas de crecimiento), forma (espira más corta, canal sifonal más corto, vueltas menos convexas con concavidad subsutural, sutura menos constreñida) y callo parietal (labio interno liso, pared parietal cubierta con una fina capa de callo adherente).

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Fusinus (Chryseofusus) bradneri (Drivas y Jay, 1990), *F. (C.) chrysodomoides* (Schepman, 1911), *F. (C.) graciliformis* (Sowerby, 1880), *F. (C.) hyphalus* M. Smith, 1940, *F. (C.) jurgeni* Hadorn y Fraussen, 2002, *F. (C.) kazdailisi* Fraussen y Hadorn, 2000 y *F. (C.) subangulatus* (von Martens, 1901) se describen brevemente, y se discute su adscripción al nuevo subgénero. Para evitar futuras complicaciones taxonómicas, se designa un lectotipo para la forma correcta de *F. (C.) chrysodomoides*.

F. (C.) acherusius (Madagascar oeste, Mozambique Channel, 1475-1530 m), *F. (C.) alisae* (N de Nueva Caledonia, 444-452 m), *F. (C.) artutus* (Filipinas, Bohol, aguas profundas), *F. (C.) cadus* (S de Nueva Caledonia, 460-470 m), *F. (C.) dapsilis* (Vietnam, aguas profundas), *F. (C.) riscus* (Nueva Caledonia, Norfolk Ridge, 394-401 m), *F. (C.) scissus* (S de Nueva Caledonia, 535 m), *F. (C.) wareni* (Nueva Caledonia, 480 m), y *F. (C.) westralis* (NO de Australia, frente a Port Hedland, 450 m) se describen como especies nuevas.

KEY WORDS: Mollusca, Gastropoda, Fasciolariidae, *Fusinus*, *Chryseofusus*, MUSORSTOM, Indo-Pacific, new subgenus, new species.

PALABRAS CLAVE: Mollusca, Gastropoda, Fasciolariidae, *Fusinus*, *Chryseofusus*, MUSORSTOM, Indo-Pacífico, nuevo subgénero, nuevas especies.

INTRODUCTION

During French expeditions, called CAMPAGNES MUSORSTOM, conducted by ORSTOM (New Caledonia) and MNHN (Paris) in the Indo-West Pacific and in particular in the seas around New Caledonia, a huge number of interesting species, many of them new to science, are collected. The Fasciolariidae are well represented in this rich material.

The purpose of the present paper is to report on this material, starting with the study of a number of peculiar fusinids from the upper bathyal zone of the Indo-Pacific, which we assign to the new subgenus *Chryseofusus*. Thanks to the large quantity of available material, a profound study was possible, comparing material from all over the Indo-West Pacific. A number of species formerly considered to be endemic, or restricted to a certain area, are now found to have a much more extensive range, a situation also observed by both authors in some lower bathyal Buccinidae. We must conclude the bathyal fauna of some areas is still poorly known and information about distribution is tentative for many bathyal Neogastropoda. In the present paper an effort is made to produce correct information on the distribution of *Chryseofusus* species. As a result *F. valdiviae* Hadorn and Fraussen, 1999 (type locality Somalia) is synonymized with *F. graciliformis* (Sowerby, 1880) (type locality Japan). The west Australian species commonly assigned to "*Siphonofusus chrysodomoides*" is found to be different from the Indonesian type material of *Fusus chrysodomoides* Schepman, 1911, and herein described as new.

MATERIAL AND METHODS

The present study is essentially based on the material collected by French research vessels and expeditions in the tropical Indo-West Pacific during the last 30 years:

(a) Material from several expeditions and surveys in the South-West Indian Ocean: BENTHEDI (1977) on board R.V. *Suroit* in the northern part of the Mozambique Channel; MD32 (1982) on board R.V. *Marion-Dufresne* around Réunion Is.; shrimp surveys conducted in the Mozambique Channel by A. Crosnier in 1972-74 on board R.V. *Vauban*, and by R. von Cosel in 1986 on board commercial trawler *Mascareignes III*; as well as material recently obtained as a by-product of commercial shrimp fisheries.

(b) Material from numerous expeditions in the New Caledonia region since 1984 (BIOCAL, MUSORSTOM 4-6, CHALCAL 2, CALSUB, SMIB 1-8, BATHUS 1-4, BERYX 11); we refer to RICHER DE FORGES (1990, 1993b), RICHER DE FORGES AND CHEVILLON (1996) and ROUX (1994) for a narrative of these cruises and station lists.

(c) Material collected since 1981 in other mainly West Pacific regions: Indonesia (CORINDON 2; KARUBAR, see CROSNIER, RICHER DE FORGES AND BOUCHET, 1997); Vanuatu (MUSORSTOM 8, see RICHER DE FORGES, FALIEX AND MENOU, 1996); Wallis and Futuna (MUSORSTOM 7, see RICHER DE FORGES, 1993a); Fiji (MUSORSTOM 10, BORDAU 1, see RICHER DE FORGES, NEWELL, SCLACHER-HOENLINGER, SCHLACHTER, NATING, CÉSA AND BOUCHET, 2000; RICHER DE FORGES, BOUCHET, DAYRAT, WARÉN AND PHILIPPE, 2000) and Tonga (BORDAU 2).

Material from these expeditions is, unless otherwise stated, deposited in MNHN. No individual catalogue number is allocated, but material is unambiguously designated (and retrievable) by the combination of expedition acronym and station number.

The method of VERDUIN (1977) was employed to count the number of protoconch whorls.

Abbreviations used in this paper:

AMS Australian Museum, Sydney, Australia
BMNH The Natural History Museum, London, Great Britain
IMT Institute of Malacology, Tokyo, Japan
IRD Institut de recherche pour le developpement, Nouméa, New Caledonia
KMMA Klaipeda Maritime Museum and Aquarium, Klaipeda, Lithuania
MNHN Muséum national d'Histoire naturelle, Paris, France
NM Natal Museum, Pietermaritzburg, South Africa
NMBE Naturhistorisches Museum Bern, Switzerland
NMNZ Museum of New Zealand *Te Papa Tongarewa*, Wellington, New Zealand
NSMT National Science Museum, Tokyo, Japan
RMNH National Museum of Natural History – Naturalis, Leiden, The Netherlands
SMNH Swedish Museum of Natural History, Stockholm, Sweden
USNM National Museum of Natural History, Smithsonian Institution, Washington D.C., USA
WAM Western Australian Museum, Perth, Australia
ZMA Zoologisch Museum, University of Amsterdam, Amsterdam, the Netherlands
ZMB Museum für Naturkunde (Zool. Museum), Berlin, Germany
KF Collection Koen Fraussen, Aarschot, Belgium
RH Collection Roland Hadorn, Röthenbach, Switzerland
CA (casier) trap
CC (chalut à crevettes) shrimp trawl
CH (chalut) trawl
CP (chalut à perche) beam trawl
DC (drague Charcot) Charcot dredge
DE (drague épibenthique) epibenthic dredge
DR (drague à roche) rock dredge
DW (drague Warén) Warén dredge
dd dead collected specimen
juv juvenile specimen
lv live collected specimen
subad subadult specimen

SYSTEMATICS

Family FASCIOLARIIDAE Gray, 1853
Genus *Fusinus* Rafinesque, 1815

Fusinus Rafinesque, 1815. *Anal. nat. tabl. univ. corps org.*: 145. Substitute name for '*Fusus* Lamarck' [=*Fusus* Bruguière, 1789], non *Fusus* Helbling, 1779.

Type species: *Murex cólus* Linnaeus, 1758, by typification of replaced name.

Description: Shells fusiform, small to large in size, elongate, with tall spire and long siphonal canal. Usually well-ribbed and with spiral threads. Columellar folds absent. Operculum corneous, shape and size corresponding to aperture, nucleus terminal.

Radula: with small tricuspid central tooth, lateral teeth curved, with 4 to about 15 strong, long pointed cusps.

Remarks: *Colus* Humphrey, 1797 is invalid (Humphrey has been ruled as non-binominal by ICZN).

Chryseofusus subgen. nov.

Type species: *Fusus chrysodomoides* Schepman, 1911 (Figs. 8-9).

Etymology: Derived from the Latin "chryseus" (adjective: made of gold), meaning "a *Fusus* made of gold", after the yellowish coloured periostracum of some of the species. Hereby also evocating the name of the type species: *Fusus chrysodomoides* Schepman, 1911.

Diagnosis: Shell small to medium, usually thin, light in weight, shape fusiform. Whorls slightly convex, shoulder slope on latter whorls concave, sometimes slightly keeled, suture indistinct. Rather strong axial ribs on upper whorls, axial sculpture on latter whorls usually weak or absent. Spiral sculpture indistinct, close-set, regular, consisting of weak primary cords and intercalated fine threads, crossed by strong, close-set, curved axial growth lines, giving the surface the texture of linen. Protoconch typical of genus, ~1 to ~1 1/4 whorls, smooth, glossy, last part (~1/4 whorl) often sculptured with some axial riblets. Aperture ovate, white, yellowish or brownish; outer lip simple, with or without internal lirae; inner lip completely smooth, parietal wall covered with an extended, adherent thin layer of callus, never forming a detached inner lip like in *F. colus*. Collumellar folds absent. Siphonal canal as long as aperture or slightly shorter, slightly curved or straight, open. Shell uniformly whitish, dirty greyish or brownish. Some species with pale reddish coloured spiral sculpture. Operculum typical of genus, corneous, shape and size corresponding to aperture, nucleus terminal. Periostracum usually yellowish or brownish, often well adherent, thick and velvety. Radula typical of genus, central tooth tricuspid, lateral teeth curved, with 4-8 strong pointed cusps.

Range and habitat: *Chryseofusus* is ecologically a deep water group, accommodating species from the Indo-Pacific upper bathyal zone, between 100 and 1900 m deep. Until present date we have not recognized any Atlantic species as belonging to *Chryseofusus*.

Species in Chryseofusus *(in alphabetical order)*: *F. acherusius* sp. nov., Mozambique Channel and New Caledonia in 1530-1900 m; *F. alisae* sp. nov., New Caledonia and Coral Sea in 300-545 m; *F. artutus* sp. nov., Philippines, Indonesia and New Caledonia in 271-435 m; *F. bradneri* (Drivas and Jay, 1990), Reunion, north Madagascar, Glorieuses and Comoro Islands in 300-750 m; *F. cadus* sp. nov., New Caledonia in 460-675 m; *F. chrysodomoides* (Schepman, 1911), Indonesia, southwest Pacific and north Madagascar in 179-797 m; *F. dapsilis* sp. nov., Vietnam, deep water; *F. graciliformis* (Sowerby, 1880), east Asia and east Africa in 50-600 m; *F. hyphalus* M. Smith, 1940, Japan, Philippines and east China Sea in 100-300 m; *F. jurgeni* Hadorn and Fraussen, 2002, southwest Madagascar in 530 m; *F. kazdailisi* Fraussen and Hadorn, 2000, Chile in 150-1200 m; *F. riscus* sp. nov., south New Caledonia in 401-430 m; *F. scissus* sp. nov., south New Caledonia in 410-580 m; *F. subangulatus* (von Martens, 1901), east Africa in 400-1134 m; *F. wareni* sp. nov., New Caledonia in 480-755 m; *F. westralis* sp. nov., Western Australia in 300-500 m.

Comparison: *Chryseofusus* differs from all other subgenera in *Fusinus* by the slightly convex, usually unkeeled whorls with subsutural concavity, the presence of axial ribs usually only on upper whorls, the weak, close-set, regular spiral sculpture crossed by strong, close-set, curved axial growth lines, giving the surface the texture of linen or a sometimes pearled appearance. Outer lip always simple; inner lip completely smooth, the never detached parietal callus consists of an extended, adherent thin layer of callus.

F. bradneri and *F. chrysodomoides*, now placed in *Chryseofusus* on the base of conchological characteristics and the fusinid radula, have generally been referred to the buccinid genus *Siphonofusus* Kuroda and Habe, 1952.

F. graciliformis and *F. hyphalus* have been referred to the conchologically similar genus *Simplicifusus* Kuroda and Habe in Kuroda, Habe and Oyama, 1971, but can be distinguished by operculum morphology.

Simplicifusus noguchii (Fig. 1) was named by Habe and Masuda for all the Japanese material previously referred to as *S. simplex* (E.A. Smith, 1879). Kuroda *et al.* referred to that material when they designated '*Fusus simplex* (Smith)' as the type species of *Simplicifusus*. BIELER AND PETIT (1996: 33), HIGO, CALLOMON AND GOTO (1999: 263) and SNYDER (2000: 175) already reported on this problem. This matter will be dealt in a future paper by Snyder (pers. comm. M. A. Snyder).

For comparison we figure the holotype of *Fusus simplex* E.A. Smith, 1879 [BMNH 1878.11.7.27, a juvenile specimen of 18.0 x 5.5 mm, type locality: south of Korea] (Figs. 5, 6). It belongs to *Fusinus s.s.* and has a typical fusinid operculum with terminal nucleus (Fig. 7).

For comparison we also figure *S. noguchii* Habe and Masuda, 1990 (Fig. 1), and its operculum (Fig. 2) which is completely different from all other treated species belonging to the new subgenus *Chryseofusus* and all other subgenera in *Fusinus* Rafinesque, 1815, which all have a typically fusinid operculum with terminal nucleus (Fig. 3). The operculum of *S. noguchii* (Fig. 2) is small, ovate, thin, much smaller than the aperture, and the nucleus is situated at lower outer side. It is identical to the operculae of the genus *Granulifusus* Kuroda and Habe, 1954 [Type species: *Fusus niponicus* E.A. Smith, 1879] (Fig. 4). Future study may show that *Simplicifusus* may be a junior synonym of *Granulifusus*.

Fusinus (Chryseofusus) chrysodomoides (Schepman, 1911) (Figs. 8-13, 76, 86)

Fusus chrysodomoides Schepman, 1911. *Rés. Siboga Exp.*, Mon 49 (1), part 4: 293, pl. 19, fig. 4; pl. 23, fig. 10.

SUBSEQUENT USE

Siphonofusus chrysodomoides (Schepman, 1911). non KOSUGE (1985: 59, pl. 23, fig. 7), WILSON (1994: 66, pl. 12, figs. 7a-b), HADORN AND FRAUSSEN (1999: pl. 3, figs. 17-18).

Fusinus chrysodomoides (Schepman, 1911). HADORN AND FRAUSSEN (1999: 117, 120).

Type material: Lectotype ZMA, SIBOGA (70.7 x 24.9 mm, lv, preserved with animal in alcohol), designated herein (Figs. 8-9). – 1 paralectotype ZMA 3.11.021, Indonesia, near Kai Islands, SIBOGA stn 262, 5° 53′ 8″ S, 132° 48′ 8″ E, 560 m (66.9 x 25.6 mm, lv).

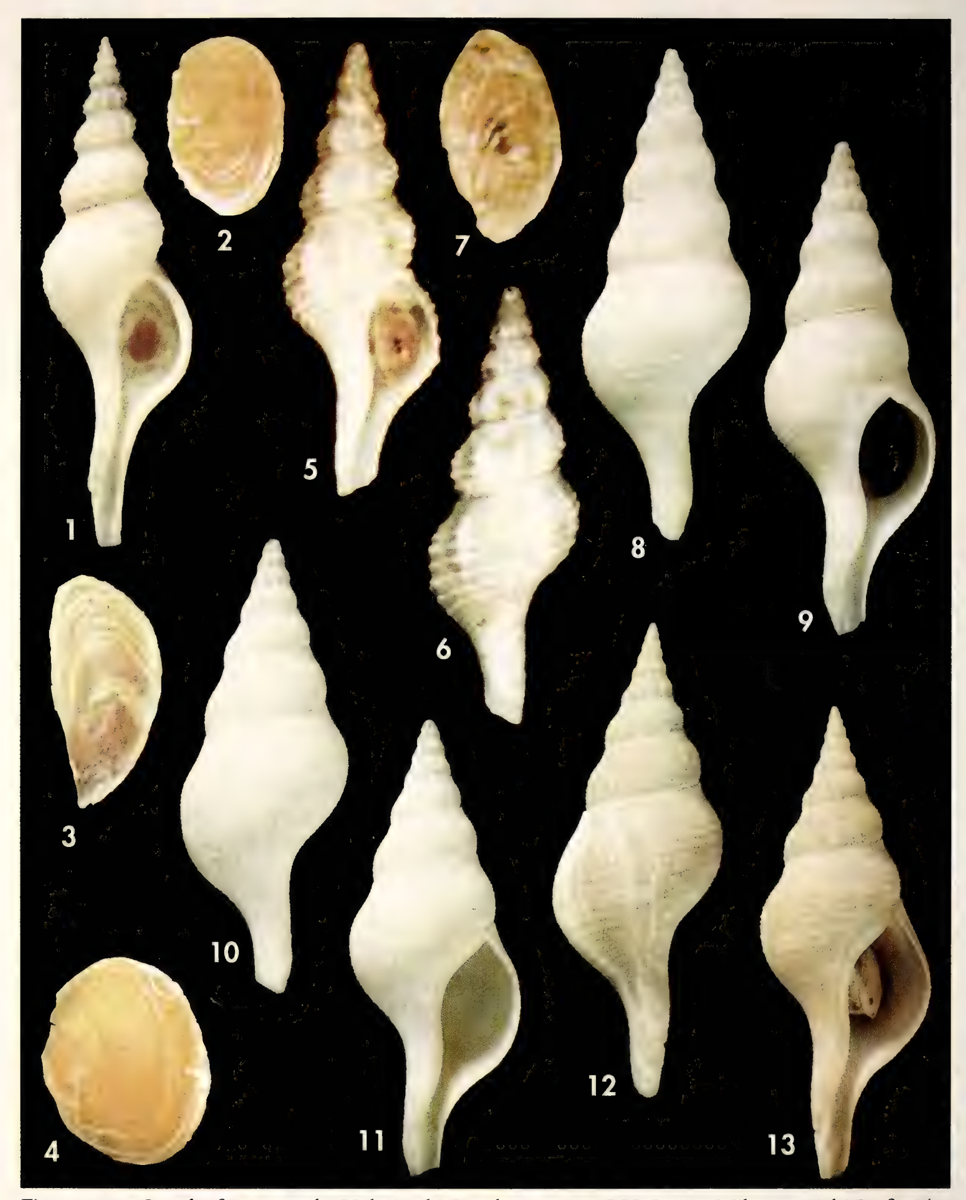
Because of the previous confusion with regard to this species and to ensure a taxonomic correct interpretation in the future, the selection of a lectotype for this species is advisable. We hereby select the specimen figured by Schepman as lectotype.

Type locality: Indonesia, Molucca-Passage, SIBOGA stn 139, 0° 11′ S, 127° 25′ E, 397 m.

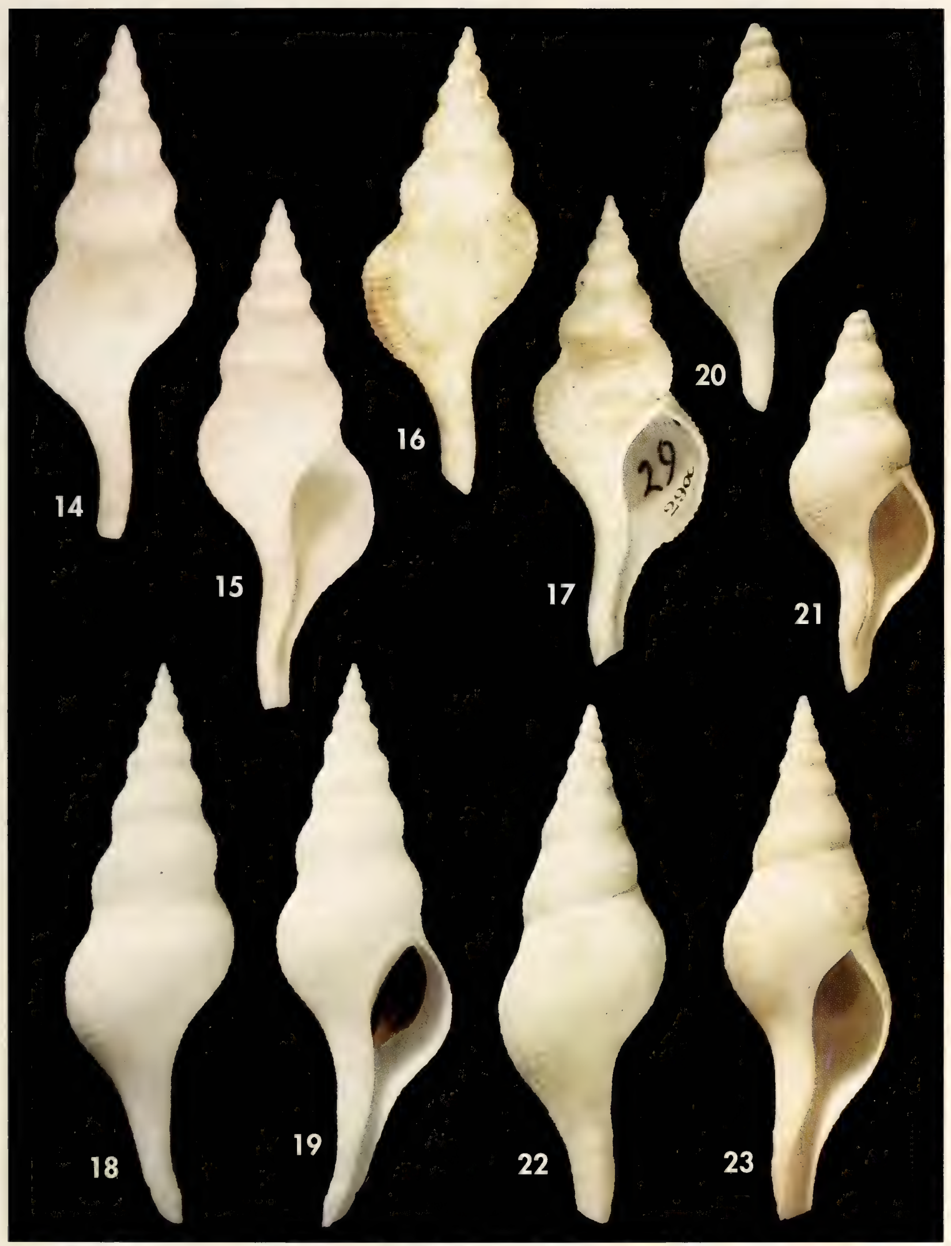
Material examined: Lectotype and paralectotype of *Fusus chrysodomoides* in ZMA.

North Madagascar, 12° 50′ S, 48° 09′ E, 580-585 m, 1 dd/1 dd juv; 12° 43′ S, 48° 15′ E, 300-340 m, 1 dd. – North Madagascar, 350-400 m, 1 dd juv/1 dd, collected by commercial boats, RH.

Indonesia, north Makassar Strait, CORINDON II stn CH276, 01° 55′ S, 119° 13′ E, 395-450 m, 1 dd. – Tanimbar Islands, KARUBAR stn DW44, 07° 52′ S, 132° 48′ E, 291-295 m, 1 dd juv. – Kai



Figures 1, 2. *Simplicifusus noguchii* Habe and Masuda, 1990. 1: RH, Japan, Mikawa, Aichi Pref., 54.8 mm; 2: Operculum. Figure 3. Operculum of *Fusinus colus* (Linnaeus, 1758). Figure 4: Operculum of *Granulifusus niponicus* (E.A. Smith, 1879). Figures 5-7. *Fusinus simplex* (E.A. Smith, 1879), Holotype BMNH 1878.11.7.27, south of Korea, 18.0 mm. 7: Operculum. Figures 8-13. *Fusinus (Chryseofusus) chrysodomoides* (Schepman, 1911). 8, 9: Lectotype ZMA, Indonesia, Molucca-Passage, 70.7 mm; 10, 11: Paralectotype ZMA 3.11.021, Indonesia, near Kai Islands, 66.9 mm; 12, 13: MNHN, Fiji, 70.9 mm. *Figuras 1, 2.* Simplicifusus noguchii *Habe y Masuda, 1990. 1: RH, Japón, Mikawa, Aichi Pref., 54,8 mm; 2: Opérculo. Figura 3. Opérculo de* Fusinus colus *(Linnaeus, 1758). Figura 4. Opérculo de* Granulifusus niponicus *(E.A. Smith, 1879). Figuras 5-7.* Fusinus simplex *(E.A. Smith, 1879), Holotipo BMNH 1878.11.7.27, S de Corea, 18,0 mm. 7: Opérculo. Figuras 8-13.* Fusinus (Chryseofusus) chrysodomoides *(Schepman, 1911). 8, 9: Lectotipo ZMA, Indonesia, Molucca-Passage, 70,7 mm; 10, 11: Paralectotipo ZMA 3.11.021, Indonesia, cerca de Kai Islands, 66,9 mm; 12, 13: MNHN, Fiji, 70,9 mm.*



Figures 14-21. *Fusinus (Chryseofusus) graciliformis* (Sowerby, 1880). 14, 15: Holotype BMNH 1880.10.15.2, Japan, 52.5 mm; 16, 17: Holotype of *Fusus sieboldi* Schepman, 1891 (junior synonym), RMNH 86858, Japan, 40.0 mm; 18, 19: KF 3200, Philippines, 81.9 mm; 20, 21: Paratype 1 of *Fusinus valdiviae* Hadorn and Fraussen, 1999 (junior synonym), KF 2811, Somalia, 47.4 mm. Figures 22, 23. *Fusinus (Chryseofusus) hyphalus* M. Smith, 1940, RH, Taiwan, 50.3 mm.
Figuras 14-21. Fusinus (Chryseofusus) graciliformis *(Sowerby, 1880). 14, 15: Holotipo BMNH 1880.10.15.2, Japón, 52,5 mm; 16, 17: Holotipo de* Fusus sieboldi *Schepman, 1891 (sinónimo junior), RMNH 86858, Japón, 40,0 mm; 18, 19: KF 3200, Filipinas, 81,9 mm; 20, 21: Paratipo 1 de* Fusinus valdiviae *Hadorn y Fraussen, 1999 (sinónimo junior), KF 2811, Somalia, 47,4 mm. Figuras 22, 23.* Fusinus (Chryseofusus) hyphalus *M. Smith, 1940, RH, Taiwan, 50,3 mm.*

Islands, KARUBAR stn CP16, 05° 17′ S, 132° 50′ E, 315-349 m, 1 dd juv; stn CP27, 05° 33′ S, 132° 51′ E, 304-314 m, 2 dd juv.
Philippines, northwest of Mindanao, Aliguay Island, 150 m, 1 dd, Snyder coll.
Vanuatu, MUSORSTOM 8 stn DW958, 20° 21′ S, 169° 47′ E, 497-570 m, 1 lv; stn DW1105, 15° 03′ S, 167° 07′ E, 154-179 m, 1 dd; stn CP1124, 15° 02′ S, 166° 57′ E, 532-599 m, 1 dd.
North New Caledonia, BATHUS 4 stn CP948, 20° 33′ S, 164° 57′ E, 533-610 m, 1 dd; stn CP950, 20° 32′ S, 164° 56′ E, 705-750 m, 1 dd.
South New Caledonia, SMIB 1 stn DW2, 22° 52′ S, 167° 13′ E, 415 m, 1 dd.
New Caledonia, Loyality Ridge, CALSUB pl. 11, 20° 52′ 5″ S, 167° 03′ E, 577 m, 1 dd; MUSORSTOM 6 stn DW483, 21° 20′ S, 167° 48′ E, 600 m, 1 dd juv.
Southwest Pacific, Tuscarora Bank, MUSORSTOM 7 stn DW555, 11° 47′ S, 178° 19′ W, 540-542 m, 1 dd.
Fiji, Bligh Water, MUSORSTOM 10 stn DW1314, 17° 16.1′ S, 178° 14.8′ E, 656-660 m, 1 lv juv; stn CP1327, 17° 13.3′ S, 177° 51.6′ E, 370-389 m, 1 fragment; stn CP1330, 17° 09.5′ S, 177° 56.3′ E, 567-699 m, 2 lv/2 lv juv; stn CP1341, 16° 52.5′ S, 177° 43.7′ E, 500-614 m, 1 lv/1 dd.
Fiji, BORDAU 1 stn CP1401, 16° 35′ S, 179° 41′ W, 600-648 m, 4 lv juv/2 dd juv; stn CP1407, 16° 40′ S, 179° 39′ E, 499-527 m, 1 lv juv; stn CP1448, 16° 45′ S, 179° 59′ E, 410-500 m, 1 lv juv; stn DW1451, 16° 45′ S, 179° 59.5′ E, 400-460 m, 2 lv juv; stn CP1502, 18° 21′ S, 178° 27′ W, 640-660 m, 1 dd.
Tonga Islands, BORDAU 2 stn DW1538, 21° 39′ S, 175° 19′ W, 471-508 m, 1 dd juv; south Nomuka group, stn DW1554, 20° 38′ S, 174° 58′ W, 482-498 m, 1 dd juv; Chenal north Nomuka, stn DW1555, 20° 11′ S, 174° 45′ W, 591 m, 1 dd juv; "Seamount", stn DW1605, 22° 17′ S, 175° 16′ W, 441 m, 2 fragments; stn CP1620, 24° 18′ S, 176° 20′ W, 572 m, 1 dd; northwest Tongatapu, stn CP1640, 21° 09′ S, 175° 24′ W, 564-569 m, 1 lv juv; stn CP1642, 21° 05′ S, 175° 23′ W, 532 m, 1 dd juv.

Description: Shell medium-sized (60.0–85.0 mm), uniformly off-white to brownish, fusiform, with rather long conical spire, solid, about 10 convex unkeeled whorls, slightly concave below suture, appressed to the preceding whorl. Suture not deep, wavy on upper whorls following the axial sculpture, and straight on latter whorls.

Upper teleoconch whorls with relatively strong axial ribs, separated by interspaces of same width. 10-14 axial ribs on uppermost whorl, 9-11 on the following 3-5 whorls, disappearing on latter whorls.

Spiral sculpture fine. 4 or 5 primary spiral cords on uppermost teleoconch whorls; 1 fine intercalated thread on fourth whorl becoming as strong as the primary ones on following whorls. Fine tertiary threads appear from sixth or seventh whorl on; the number increases to 3 or 4 of unequal strength on body whorl. Spiral sculpture crossed by curved, strong, well-visible and close-set growth lines, giving surface the texture of linen.

Aperture ovate, pinched at both ends, white. Parietal callus thin, smooth and glossy, extended and adherent to parietal wall. Columellar folds absent. Outer lip thin, simple, smooth inside.

Siphonal canal relatively short, about as long as aperture, curved. Outer side sculptured with fine spirals, crossed by growth lines.

Operculum typical of genus, corneous, brown, shape and size corresponding to aperture, nucleus terminal.

Periostracum brown.

Radula (Figs. 76, 86) typically fusinid. Central tooth with tricuspid base, the median cusp longest, base broader than the notched anterior margin. Lateral teeth broad, strongly curved, with 6-9 cusps of subequal length, at both ends with a small denticle.

Range and habitat: Indonesia, Philippines, northern Madagascar, and southwestern Pacific (New Caledonia, Vanuatu, Fiji and Tonga) between 179 and 797 m deep.

Remarks: *F. chrysodomoides* was placed in the genus *Siphonofusus* (Buccinidae) by authors, but the radula (Figs. 76, 86) and conchological characteristics are typical of the genus *Fusinus*. The Australian shells figured as *Siphonofusus chrysodomoides* by WILSON (1994: 66, pl. 12, figs. 7a-b) or as *Fusinus chrysodomoides* by HADORN AND FRAUSSEN (1999: pl. 3, figs. 17-18) are clearly different from the Indonesian type material. The Australian species is

described as *F. westralis* sp. nov. later on in this paper. *F. westralis* differs from *F. chrysodomoides* by the clearly larger shell size, the more slender and more extended spire, the larger number of whorls, by the more concave shoulder slope especially on the lower whorls, the narrower interspaces between the axial ribs on upper whorls, and finally by the finer spiral sculpture and the larger number of very fine intercalated spiral threads.

F. chrysodomoides from New Caledonia usually have more prominent and broader axial ribs on upper whorls. All specimens from Fiji and Tonga and most specimens from New Caledonia are brownish coloured as opposed to the white coloured type material of *F. chrysodomoides* from Indonesia, the white coloured specimens from the East African coast and one specimen from New Caledonia (CALSUB 1989 pl. 11). However, we found no evidence to separate the white and the brownish coloured specimens. Moreover, the radulae of the New Caledonian specimens are nearly identical to the figured radula of the paralectotype of *F. chrysodomoides* (SCHEPMAN, 1911: Fig. 10).

BOUCHET AND WARÉN (1986: 475) noted, that *Manaria insularis* Okutani, 1968 "resembles closely *Fusus chrysodomoides* Schepman, 1911". After examination of the holotype of *Manaria insularis* [NSMT Mo. 60220; Type locality: Japan, off Hachijo Island, R/V Soyo-Maru stn B3, 33° 08.3′ N, 140° 01.8′ E, 460 m] and direct comparison with the type material of *F. chrysodomoides* we found out, that both species are clearly distinct. *F. chrysodomoides* clearly has a larger adult size, a smaller spire angle (~35° -38° / *M. insularis*: ~42°), a proportionally longer spire and a narrower siphonal canal. The axial ribs are usually restricted to the spire tip, are more prominent and separated by wider interspaces. The spiral sculpture on upper whorls clearly consists of less distinct spiral cords and is also present in the interspaces between the axial ribs. The growth lines are prominent and well-visible on all whorls, a characteristic of all *Chryseofusus*. *M. insularis* only has inconspicuous growth lines. *F. chrysodomoides* has a smooth columella as opposed to *M. insularis*, which has one weak columellar fold.

No genus nor family (Buccinidae or Fasciolariidae) can be ascertained to accomodate *M. insularis*, until more material with animal and radula, is found.

Fusinus (Chryseofusus) graciliformis (Sowerby, 1880) (Figs. 14-21, 87)

Fusus graciliformis Sowerby, 1880. *Thes. Conch., Monogr.* Fusus, 4.: 80, pl. VII, fig. 62.

SYNONYMS

Fusus sieboldi Schepman, 1891. *Notes Leyden Mus.*, 13 (2): 62; 1891: *Notes Leyden Mus.*, 13 (17): 157, pl. 9, figs. 3a, b.

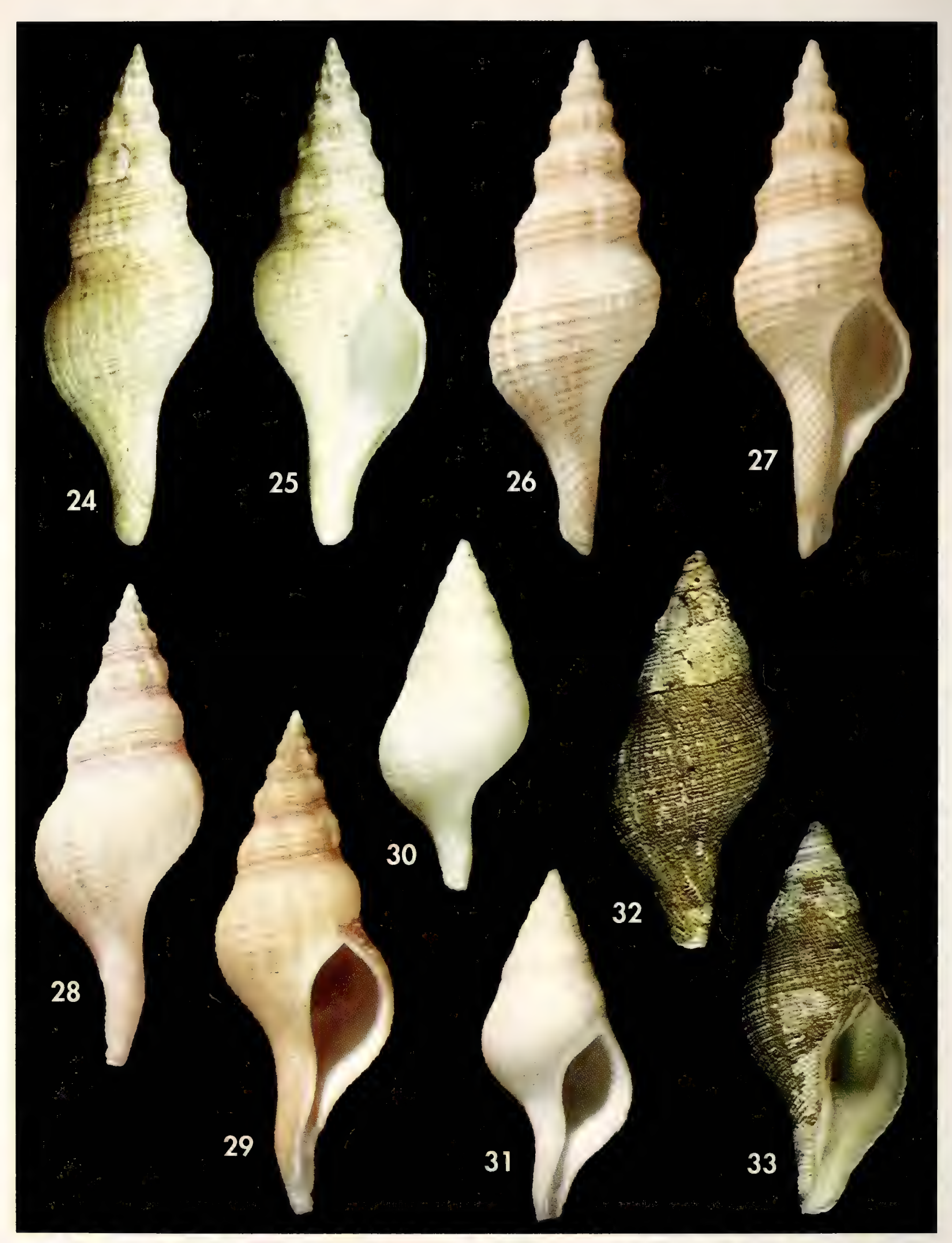
Fusinus valdiviae Hadorn and Fraussen, 1999. *Vita Marina*, 46 (3-4): 117-120, figs. 11-16, text fig. 2.

SUBSEQUENT USE

Fusinus graciliformis (Sowerby, 1880). FUJITA (1929: 90, pl. 3, fig. 11).

Simplicifusus graciliformis (Sowerby, 1880). KURODA AND HABE in Kuroda, Habe and Oyama (1971: 282-283, pl. 51, fig. 2).

Type material: *F. graciliformis*: Holotype BMNH 1880.10.15.2 (52.5 x 18.0 mm, dd) – *F. sieboldi*: Holotype RMNH 86858 (40.0 x 15.2 mm, dd). – *F. valdiviae*: Holotype MNHN (50.2 x 18.9 mm, lv subad); 11 paratypes, Somalia, deep water, KF, RH and B. Briano (42.5-62.9 mm, dd subad); 1 paratype BMNH 1998187, Somalia, deep water (48.0 x 17.1 mm, dd subad); 1 paratype NMBE 1727.99, Somalia, deep water (45.7 x 17.0 mm, dd subad); 1 paratype IMT-99-2, Somalia, deep water (44.9 x 18.3 mm, dd subad); 3 paratypes, Gulf of Aden, Somalia, deep water, H. Dekker (49.0-60.5 mm, dd subad); 1 paratype ZMB, VALDIVIA stn 256, 01° 49′ N, 45° 29′ E, 1134 m (47.2 x 18.3 mm, dd subad).



Figures 24-27. *Fusinus (Chryseofusus) subangulatus* (von Martens, 1901). 24, 25: Lectotype ZMB 59931, south Somalia, near Kismaayo, 71.1 mm; 26, 27: RH, Somalia, 55.3 mm. Figures 28-31. *Fusinus (Chryseofusus) bradneri* (Drivas and Jay, 1990). 28, 29: MNHN, Reunion, off Saint-Gilles, 53.5 mm; 30, 31: MNHN, Glorieuses Islands, dwarf form?, 48.4 mm. Figures 32, 33. *Fusinus (Chryseofusus) kazdailisi* Fraussen and Hadorn, 2000, Holotype KMMA LJM925, Chile, Nazca Ridge, 40.0 mm. *Figuras 24-27.* Fusinus (Chryseofusus) subangulatus *(von Martens, 1901). 24, 25: Lectotipo ZMB 59931, S de Somalia, cerca de Kismaayo, 71,1 mm; 26, 27: RH, Somalia, 55,3 mm. Figuras 28-31.* Fusinus (Chryseofusus) bradneri *(Drivas y Jay, 1990). 28, 29: MNHN, Reunion, frente a Saint-Gilles, 53,5 mm; 30, 31: MNHN, Glorieuses Islands, ¿forma enana?, 48,4 mm. Figuras 32, 33.* Fusinus (Chryseofusus) kazdailisi *Fraussen y Hadorn, 2000, Holotipo KMMA LJM925, Chile, Nazca Ridge, 40.0 mm.*

Type locality: *F. graciliformis*: Japan. *F. sieboldi*: Japan. *F. valdiviae*: Somalia, between Ras Hafun and Djibouti, approximately 400 m deep.
Material examined: The holotypes of *F. graciliformis* and *F. sieboldi*, and all the type material of *F. valdiviae*.
Madagascar, southwest Madagascar, Tulear, 500-800 m, collected by commercial boats, 4 dd, B. Briano; 1 dd, RH. – West Madagascar, off Morondava, 600 m, collected by commercial boats, 3 dd, KF; 2 dd, RH. – North Madagascar, 12° 52′ 0″ S, 48° 10′ 3″ E, 420-428 m, 1 dd juv; 12° 42′ 9″ S, 48° 12′ 1″ E, 445-455 m, 1 dd juv.
Philippines, south Bohol, Balicasag Island, off Panglao, 380 m, 1 lv, KF 2819. – Bohol, Balicasag, 275 m, 1 lv, C. Takahashi; 1 lv, B. Rogers. – North Mindanao, north of Dipolog, Aliguay Island, deep water, 3 lv, KF 3200; 2 lv, RH.

Description: Medium-sized shell (42.5-90.0 mm) with about 9-11 convex whorls, surrounded by a weak subsutural concavity. Suture appressed to preceding whorl, not incised.

Protoconch broken or eroded in all examined specimens and therefore unknown.

Eight or nine rather strong and narrow axial ribs, reaching from suture to suture and separated by narrow and not very deep impressed interspaces on the 2 uppermost teleoconch whorls. On the following 2 or 3 whorls the number of ribs increases up to 11-13 per whorl, becoming somewhat broader and lower and usually stopping below the upper suture; interspaces between ribs become shallower and less distinct. On antepenultimate or penultimate whorl the axial ribs become very low and less distinct and the spacing becomes irregular. Axial ribs always obsolete on body whorl and usually also on penultimate whorl.

Teleoconch begins with 5 or 6 strong but low and rounded spiral cords. Starting with the second or third whorl an additional clearly finer spiral cord appears just below suture, and a fine intercalated spiral thread appears between each pair of cords. On the following whorls the number of fine spiral threads increases by intercalation; up to 5 or 6 between each pair of primary cords on body whorl. In the subsutural concavity only some fine threads. The spiral sculpture is crossed by rather strong and well-visible curved growth lines, giving the surface of the shell the texture of linen.

Aperture ovate, whitish to yellowish in colour, acute at posterior end. Parietal callus thin, smooth and glossy, appressed to lower part of body whorl. Columellar folds absent. Outer lip simple and thin, sculptured with numerous fine internal lirae; outline of lip strikingly curved like an elongated reversed 'S'. Siphonal canal shorter than aperture length, conspicuously curved. Outer side ornamented with numerous fine, low and regularly spaced spiral cords which are intercalated by numerous fine spiral threads.

Operculum corneous, colour pale reddish brown, thin, shape and size corresponding to aperture. Outer side with fine concentric growth lines. Typical of genus, with terminal nucleus.

Periostracum thin, olive-green, not hairy.

Radula (Fig. 87) typical of genus. Central tooth nearly rectangular, tricuspid, median cusp somewhat stronger. Lateral teeth strongly curved, with 6 or 7 long, strong and pointed cusps; outermost one much larger than all others. At both ends of lateral tooth with a small denticle.

Range and habitat: Japan (Bōsō peninsula and southwards), East China Sea, Philippines, South China Sea (HIGO ET AL., 1999: 263), and along the East African coast, from the Gulf of Aden, Djibouti, Somalia (HADORN AND FRAUSSEN, 1999: 120) to southwestern Madagascar. Between 50 and 1134 m deep, on sandy bottom.

Remarks: Comparing both the holotypes of *F. graciliformis* (Figs. 14-15) and *F. sieboldi* (Figs. 16-17) shows, that the latter is doubtless a junior synonym. Both holotypes are nearly identical in size, shape, sculpture and both were found in Japan.

F. valdiviae (Figs. 20-21) appears to be conspecific, the description based on subadult East African specimens. HADORN AND FRAUSSEN (1999) compared *F. valdiviae* with *F. westralis* (described in this paper) misidentified in the 1999 paper as *F. chrysodomoides*. After examination of the holotype of *F. graciliformis* and other material mainly from the Philippines we treat the conchologically not distinguishable *F. valdiviae* from East Africa provisionally as a junior synonym of *F. graciliformis*. Further study can reveal a subspecific status for *F. valdiviae*. The radula of *F. graciliformis* is still unknown, the radula of *F. valdiviae* was figured by HADORN AND FRAUSSEN (1999, Fig. 87).

F. hyphalus differs from *F. graciliformis* by having a more slender spire tip, a smaller adult size, a thinner and lighter shell, and by the less convex whorls.

Fusinus (Chryseofusus) hyphalus M. Smith, 1940 (Figs. 22, 23)

Fusinus hyphalus M. Smith, 1940. *The Nautilus*, 54 (2): 43, pl. 2, fig. 9.
SUBSEQUENT USE.
Fusinus (Simplicifusus) hyphalus M. Smith, 1940. KIRA (1962: 85).
Simplicifusus hyphalus (M. Smith, 1940). HIGO *ET AL.* (1999: 263).

Type material: Holotype in M. Smith' s collection (36.5 x 12.5 mm) (not seen).
Type locality: Japan, off Tosa, 183 m deep.
Material examined: Taiwan, deep water, 1 lv juv/1 lv, RH. – Keelung, 1 lv/1 dd subad, RH.

Description: Shell entirely white or pale, medium-sized (36.0-75.0 mm), thin, lightweight, fusiform, elongate, consisting of about 8 or 9 slightly convex whorls with only slight subsutural concavity. Body whorl often inflated and ventricose in adult specimens. Suture indistinct, straight.

Protoconch typical of genus, 1 $^{1}/_{2}$ whorls, bulbous, white, glossy, final part ($^{1}/_{4}$ whorl) sculptured with 4 or 5 strong axial riblets, diameter 1.0-1.1 mm.

Weak, narrow and inconspicuous axial ribs on upper 5 or 6 teleoconch whorls, separated by narrow interspaces, disappearing on latter whorls. 10 or 11 axial ribs on the 4 uppermost teleoconch whorls extending from suture to suture, 11-13 on fifth or sixth whorl, becoming weaker and disappearing on the following whorl.

Teleoconch beginning with 3 relatively weak primary spiral cords, the 2 lower ones slightly stronger. From second whorl on, a fine secondary spiral thread appears between primary cords and below suture, becoming as strong as the primary cords on following whorls. From fourth postnuclear whorl on, 2-4 fine intercalated tertiary threads appear between primary and secondary cords. Axial growth lines fine but distinct on all whorls, crossing spiral sculpture and giving the surface a pearled appearance.

Aperture ovate, whitish, relatively large. Edge of outer lip simple, slightly crenulated, internal side smooth or with some weak internal lirae. Inner lip smooth, glossy, parietal callus appressed to parietal wall, columellar folds absent. Siphonal canal thin, slightly curved, as long as aperture, open.

Periostracum thin, persistent, straw-brown in colour.

Operculum typical of genus, corneous, brown, shape and size corresponding to aperture, nucleus terminal.

Range and habitat: Japan, Enshu-nada and westwards, East China Sea at 100-300 m on sandy bottom (HIGO *ET AL.*, 1999: 263); Philippines, Cebu and Bohol (SPRINGSTEEN AND LEOBRERA, 1986: 177).

Remarks: *F. hyphalus* resembles *Simplicifusus noguchii*, but belongs to *Fusinus* because of the typical fusinid operculum. *Simplicifusus noguchii* differs from *F. hyphalus* by having a smaller adult size, a more slender white-coloured shell, and by the presence of

axial ribs usually on all whorls, stronger on upper whorls, becoming weaker on body whorl, and by the small, nearly round operculum, which is typical of *Simplicifusus* (Fig. 2).

F. graciliformis can be distinguished by the larger adult size, the longer spire, the more convex whorls, and by often having rather strong, broad axial ribs on upper whorls.

Fusinus (Chryseofusus) subangulatus (von Martens, 1901) (Figs. 24-27, 77)

Fusus? subangulatus von Martens, 1901. *Sitz.-Ber. Ges. Nat. Freunde Berlin*, Jahrg. 1901: 21.
SUBSEQUENT USE
Fusus subangulatus von Martens. VON MARTENS (1904: 102-103, pl. 2, fig. 11).
Fusinus subangulatus (von Martens, 1903). HADORN AND FRAUSSEN (1999: 112-117, pl. 1, figs. 1-8, text fig. 1, non pl. 2, figs. 9-10 =*Fusinus jurgeni* Hadorn and Fraussen, 2002).

Type material: Lectotype ZMB 59931, VALDIVIA (71.1 x 23.7 mm, dd), designated by HADORN AND FRAUSSEN (1999). – 3 paralectotypes ZMB, south Somalia, near Kismaayo, VALDIVIA stn 253, 0° 27′ S, 42° 47′ E, 638 m (71.3 x 25.4 mm, lv); south Somalia, near Mogadisho, VALDIVIA stn 256, 1° 49′ N, 45° 29′ E, 1134 m (37.1 mm, spire fragment, dd); Tanzania, Pemba Channel, VALDIVIA stn 246, 5° 24′ S, 39° 19′ E, 818 m (39.9 x 14.5 mm, incomplete specimen with heavy incrustations, dd).
Type locality: South Somalia, near Kismaayo, VALDIVIA stn 254, 0° 29′ S, 42° 47′ E, 977 m.
Material examined: Lectotype and the 3 paralectotypes in ZMB.
Somalia, deep water, 3 dd, KF; 1 dd, RH. – Between Ras Hafun and Djibouti, 400 m, 1 dd, KF; 1 dd, RH.

Description: Shell rather large (up to 77.2 mm), relatively heavy in weight. Background colour whitish to yellowish with pale reddish coloured spiral sculpture. 9 or 10 convex whorls, latter whorls distinctly keeled, shoulder slope clearly concave. Axial and spiral sculpture rather weak. Aperture relatively large, siphonal canal short and distinctly curved. Protoconch broken in all known specimens. Suture appressed to the preceding whorl, wavy on upper whorls, straight on penultimate and body whorl.

Upper postnuclear whorls slightly convex, sculptured with 9 or 10 narrow and rather weak axial ribs, reaching from suture to suture; interspaces between them narrow and only weakly impressed. Beginning at the appearance of the peripheral keel (usually on fourth or fifth teleoconch whorl) the interspaces between the axial ribs become wider; the ribs terminate below the upper suture and are reduced to broad, rounded knobs which are most prominent at the periphery. On the penultimate whorl they become weaker and irregular, fading out suddenly. About 9-13 axial knobs on latter whorls, but usually obsolete on body whorl and sometimes also on penultimate whorl.

Four strong spiral cords on the first teleoconch whorl, 5 or 6 on the following whorls. On latter whorls, beginning with the peripheral keel, several rather fine additional spiral threads appear on shoulder. Starting with third or fourth postnuclear whorl a fine spiral thread appears between each pair of stronger cords. The number of fine threads increases by intercalation; up to 8 fine intercalated threads of unequal strength on body whorl. Central spiral cord and the 2 cords below it somewhat stronger than all others. Spiral sculpture crossed by conspicuously strong growth lines, well-visible on all whorls.

Aperture rather large, narrowly ovate, acute at posterior end, yellowish or white in colour. Outer lip simple and sharp, without or with only weak internal lirae. Inner lip appressed to parietal wall, smooth. Columellar folds absent. Siphonal canal rather short for genus, shorter than aperture length, slightly

curved, widely open. Outer side ornamented with fine spiral cords and numerous intercalated threads.

Operculum rather thin, colour pale reddish brown, corneous. Shape and size corresponding to aperture, typical of genus, with terminal nucleus.

Radula (Fig. 77) typical of the genus, consisting of an elongated central tooth with a tricuspid base. Median cusp clearly longest. Rounded base broader than notched top. Lateral teeth conspicuously broad, strongly curved with 7-8 rather short, strong and pointed cusps; 2 outermost cusps broader and stronger.

Range and habitat: East Africa, from Djibouti, Gulf of Aden to the Pemba Channel, Tanzania, 400-1134 m deep on blue silt and pteropod ooze.

Remarks: Rediscovered by HADORN AND FRAUSSEN (1999), the typically fusinid radula was figured for the first time (Fig. 77). A specimen from off the Somalian coast figured on pl. 2, figs. 9-10 as *F. subangulatus* "broad form" is now referred to *F. jurgeni* Hadorn and Fraussen, 2002.

F. jurgeni has a larger adult size and has a broader shell, a longer siphonal canal, a larger number of spiral cords which are clearly finer and denser.

F. chrysodomoides is most similar to *F. subangulatus* and can be distinguished by having a somewhat larger adult size, uncoloured spiral cords, a larger number of weaker spiral cords, often broader and somewhat stronger axial ribs, a more ventricose body whorl, stronger axial growth lines, usually a more curved siphonal canal and finally some minor differences in radula morphology.

Fusinus (Chryseofusus) bradneri (Drivas and Jay, 1990) (Figs. 28-31, 78)

Siphonofusus bradneri Drivas and Jay, 1990. *Venus*, 49 (4): 272-273, pl. 1, fig. 6.
SUBSEQUENT USE
Peristernia caledonica (Petit, 1851). DRIVAS AND JAY (1998: 39, sp. 27).
Fusinus bradneri (Drivas and Jay, 1990). FRAUSSEN (1999: 81); HADORN AND FRAUSSEN (1999: 117, 120).

Type material: Holotype in MNHN (54.0 x 18.0 mm, dd). – 4 paratypes (46.6-77.5 mm, dd), from the type locality, in the collections of Jean Drivas and Maurice Jay.
Type locality: West coast of Reunion Island, St. Paul's Bay, 750 m.
Material examined: Holotype in MNHN.
Comoro Islands, Mayotte, east Passe Longogori, BENTHEDI 1977 stn 33, 12° 53′ 5″ S, 45° 16′ 3″ E, 275-400 m, 1 dd.
Glorieuses, west Grande Glorieuse, BENTHEDI 1977 stn 98, 11° 35′ 5″ S, 47° 16′ 4″ E, 280-460 m, 1 dd (dwarf form).
North Madagascar, 12° 42′ 4″ S, 48° 14′ 1″ E, 375-380 m, 1 lv.
Reunion, Baie de la Possession, 600 m, 1 lv/2 dd. – Off Saint-Gilles, 700 m, 3 dd. – Reunion, Campagne MD32 stn CA70, 21° 23′ 01″ S, 55° 29′ 03″ E, 700-730 m, 1 dd; stn CP129, 20° 51′ S, 55° 36′ E, 290-300 m, 1 dd juv; stn DR62, 21° 09′ S, 55° 12′ E, 630-710 m, 1 dd juv; stn DC134, 20° 51′ S, 55° 39′ E, 650-750 m, 1 dd juv; stn CP144, 20° 50′ S, 55° 35′ E, 605-620 m, 1 lv juv. – Reunion, west coast, St. Paul, 750-800 m, 1 dd, KF 2746; 5 dd, RH. – Reunion, off St. Paul's Bay, 750-800 m, 1 lv, KF.

Description: Shell fusiform, medium sized (46.6-77.5 mm), solid, consisting of 7 or 8 convex teleoconch whorls with subsutural concavity. Suture indistinct, appressed to the preceding whorl, wavy on axially ribbed part of spire, straight on latter whorls. Reddish-brown coloured, the stronger spirals and below the suture darker.

Protoconch pale, typically fusinid.

About 7 strong, conspicuously broad axial ribs separated by wide interspaces on upper whorls, disappearing on penultimate whorl.

Four strong primary spiral cords on upper teleoconch whorls; from fourth whorl on an intercalated secondary fine spiral thread between primary cords, soon becoming as strong as primary ones on antepenultimate whorl. At the same

time 1-3 clearly weaker tertiary intercalated threads appear on body whorl.

Fine, but well-visible growth lines intersect the spiral sculpture giving the surface a finely granulate appearance.

Aperture whitish, relatively small, ovate, pinched at both ends. Outer lip relatively thick in adult specimens, weakly denticulate, sculptured with numerous close-set and distinct internal lirae. Columellar callus smooth, adherent. Columellar folds absent.

Siphonal canal long, rather narrow, slightly curved.

Operculum typical of genus, corneous, reddish-brown, shape and size corresponding to aperture, nucleus terminal.

Radula (Fig. 78) typical of genus. Tricuspid elongate central tooth. Cusps strong, long and pointed, projecting below the base, central one somewhat stronger. The rounded top is narrower than the base. Lateral teeth have 5 strong pointed cusps with incurved tips. Outermost one clearly the strongest. With a small denticle at both ends.

Range and habitat: Reunion (300-750 m deep), north Madagascar (375-380 m), Glorieuses (280-460 m) and Comoro Islands (275-400 m). Previously only known from Reunion. Live collected specimens between 380 and 750 m deep, dead shells between 300 and 750 m.

Remarks: Described as a *Siphonofusus* (Buccinidae), but referred to *Fusinus* by HADORN AND FRAUSSEN (1999) on the basis of conchological resemblance to *F. valdiviae* (a junior synonym of *F. graciliformis*), *F. westralis* sp. nov. (misidentified as "*F. chrysodomoides*") and *F. subangulatus*. The generic position was still not confirmed because of the unknown radula. A juvenile specimen of *F. bradneri*, stored in MNHN, had the dried animal preserved inside the shell. The radula (Fig. 78) is found to be typical of the genus *Fusinus* and the placement in Fasciolariidae is therefore correct.

F. chrysodomoides most closely resembles *F. bradneri*, but differs in having a slightly larger number of axial ribs on upper teleoconch whorls, in the narrower axial ribs and the narrower interspaces, the weak or absent lirae inside the aperture, in the uniformly whitish or greyish colour of the shell, in the usually shorter and less twisted siphonal canal, and finally in different radula morphology (more elongated and narrower central tooth, smaller number of cusps on lateral teeth).

F. graciliformis differs by having a somewhat larger and thinner shell, a larger number of narrower axial ribs on upper whorls with narrower interspaces, an aperture with weaker and indistinct internal lirae, and a uniformly white or rarely flesh coloured shell.

One probably dwarf specimen (Figs. 30-31) from the Glorieuses Islands (BENTHEDI stn 98) clearly has a shorter shell, a shorter spire and a shorter siphonal canal, a less constricted suture and less convex whorls. More material and study is necessary to conclude if this is a dwarf form or a distinct species.

DRIVAS AND JAY (1998: 39, sp. 27) figured a specimen of *Chryseofusus* misidentified as *Peristernia caledonica* (Petit, 1851). We examined two syntypes of *Turbinella caledonica* Petit, 1851 in MNHN [Type locality: New Caledonia] and found out, that the identification made by Drivas and Jay could definitively not be correct. We consider the figured shell a juvenile *F. bradneri*, because of the close resemblance to the juvenile material collected during the Campagne MD32 1982 near Reunion.

Fusinus (Chryseofusus) jurgeni Hadorn and Fraussen, 2002 (Figs. 34-37, 81)

Fusinus subangulatus (von Martens, 1903) "broad form". HADORN AND FRAUSSEN (1999: 115, pl. 2, figs. 9-10; 116).

Fusinus cf. bradneri Drivas and Jay, 1990. MALLARD (2001: 12, fig. 12).

Fusinus jurgeni Hadorn and Fraussen, 2002. *Iberus*, 20 (1): 67-76, figs. 9-14, 20 (radula).

Type material: Holotype (94.2 x 31.7 mm, lv) and one paratype (83.4 x 30.1 mm, dd) in MNHN, 5 paratypes in NM L5693/T1875 (89.7 x 32.6 mm, dd), KF (84.0 x 30.4 mm, dd), RH (89.1 x 31.0 mm, 76.5 x 26.6 mm, both dd), B. Rogers (90.5 x 32.2 mm, dd).
Type locality: Southwest Madagascar, Mozambique channel, 22° 22′ S, 43° 03′ E, 530 m.
Material examined: The live-taken holotype, collected by R. von Cosel during a shrimp stock survey by the commercial trawler *Mascareignes III* in 1986.
Madagascar, southwest Madagascar, Tulear, 500-800 m, collected by commercial boats, 5 paratypes MNHN, NM L5693/T1875, KF, RH; 4 dd, B. Briano; 1 dd, RH. – Southwest Madagascar, off Tulear, deep water, 1 dd, paratype B. Rogers. – West Madagascar, off Morondava, 600 m, 3 dd, KF 3208. Somalia, trawled between Ras Hafun and Djibouti, 400 m, 1 dd, KF 1631.

Description: Shell large (up to 100.1 mm), fusiform, light in weight, spire elongate, siphonal canal relatively long for subgenus. 11 or 12 convex whorls, latter whorls often slightly keeled, shoulder slope concave. Shell uniformly white, sometimes with reddish-brown tinged spiral cords and with some weak reddish brown axial strikes.

Protoconch typically fusinid, consisting of 1 to 1 $^{1}/_{4}$ smooth, glossy whorls. Transition to teleoconch eroded and details not recognizable. Diameter 0.9-1.0 mm.

Eight or nine rather narrow and weak axial ribs on 3 uppermost teleoconch whorls, extending from suture to suture. 8-10 axial ribs on following whorls, withdrawing from upper suture. Axial sculpture weak or absent on penultimate whorl. Body whorl without axial sculpture. Interspaces narrow on upper whorls, slightly broader and less pronounced on latter whorls.

Spiral sculpture crossed by strong, curved axial growth lines. 3 strong spiral cords on first teleoconch whorl, the uppermost weaker. From second whorl on, a fine intercalated secondary spiral thread appears. From fifth or sixth whorl on, secondary spirals becoming as strong as primary ones and additional fine tertiary spiral threads appear. On latter whorls 3-5 intercalated fine threads visible between stronger spirals.

Aperture rather large, ovate, upper end pointed, white coloured. Outer lip simple and smooth, without internal lirae. Inner lip completely smooth, curved. Parietal callus thin, parietal wall covered with an extended adherent layer of callus. Columellar folds absent. Siphonal canal almost straight or slightly curved, as long as aperture.

Operculum typically fusinid, corneous, ovate, pointed below, dark brown, shape and size corresponding to aperture, with terminal nucleus. Outer side ornamented with strong concentric growth lines; inner side with a strongly callused edge along the outer side.

Periostracum unknown.

Radula (Fig. 81) typical of genus. Central tooth almost rectangular in shape; base slightly convex, top straight or slightly concave, both sides concave, tricuspid, with strong, short, pointed cusps projecting below base. Lateral teeth elongate, curved, with 7 strong, long, pointed cusps. At both ends with a small denticle.

Range and habitat: Known from southwestern Madagascar, between 500 and 800 m deep. One live collected specimen 530 m deep. One record from Somalia, collected between Ras Hafun and Djibouti, 400 m deep (KF 1631).

Remarks: *F. subangulatus* has a somewhat smaller and heavier shell, a smaller number of whorls, a more slender shape, a shorter siphonal canal and a stronger spiral sculpture with a smaller number of spiral cords.

F. chrysodomoides differs in being usually smaller, in having a heavier and stouter shell, a less constricted suture, a sometimes brownish coloured aperture and a uniformly coloured shell, and a spiral sculpture with a more beaded appearance.

F. bradneri differs by its smaller size, the more solid and reddish brown coloured shell, the less constricted suture, the broad and strong axial ribs on upper whorls, the strong close-set lirae inside the aperture, and by having a smaller number of intercalated fine threads between the stronger spiral cords.

Fusinus (Chryseofusus) kazdailisi Fraussen and Hadorn, 2000 (Figs. 32-33, 79)

Fusinus kazdailisi Fraussen and Hadorn, 2000. *Novapex*, 1 (1): 15-19, figs. 1-12.

Type material: Holotype in KMMA LJM925 (40.0 x 17.0 mm, lv). – Chile, Nazca Ridge, Ecliptic Bank, 110-150 m (56.0 x 23.0 mm, dd, paratype 1, H. Danila; 57.0 x 23.0 mm, dd, paratype 2, KF; 48.0 x 20.0 mm, dd, paratype 3, RH; 43.0 x 18.0 mm, lv, paratype 4, MNHN). – Chile, Nazca Ridge, Mesyatsev Bank, 260-280 m (45.0 x 19.0 mm, lv, paratype 5, KF). – Chile, off Valparaiso, 1200 m (52.0 x 22.0 mm, lv, paratype 6, A. Nora; 51.0 x 20.0 mm, lv, paratype 7, KF). – unknown locality (47.0 x 19.0 mm, lv, paratype 8, C. and J. Hemmen; 57.0 x 22.0 mm, lv, paratype 9, Haus der Natur, Cismar, Germany; 48.0 x 20.0 mm, lv, paratype 10, Haus der Natur, Cismar, Germany).
Type locality: Off Chile, Nazca Ridge, Ecliptic Bank, in deep water.
Material examined: Holotype in KMMA and all paratypes.
Chile, Nazca Ridge, Ecliptic Bank, 110-150 m, 1 dd, KF; 1 lv, RH.
Unknown locality, 1 dd, RH; 1 dd, KF 2944; 1 dd, R. Kelly.

Description: Shell medium sized (40.0-57.0 mm), solid, shape fusiform, semi-slender. Whorls about 6 in number, showing a weak subsutural concavity. Suture appressed to preceding whorl. Shell dirty greyish to brown or pale reddish-brown. Protoconch missing in all known specimens.

Eight to fourteen rather strong and narrow axial ribs, traversing from suture to suture, on upper whorls. Interspaces rather narrow. Axial ribs become weaker on following whorls and finally disappear. All whorls densely covered with fine, sometimes slightly curved growth lines, often not visible on their own but recognizable by low papillae formed on spiral cords, giving the surface of latter whorls a pearled appearance.

Seven to nine strong and rounded primary spiral cords on first remaining teleoconch whorl, separated by deep and narrow interspaces. On second whorl, interspaces become broader, tending to be similar in size to spiral cords. 9 or 10 primary spiral cords on following whorl, 12-14 on penultimate whorl. On third or fourth whorl 1 fine intercalated secondary spiral thread appears between each pair of primary cords. Furthermore, 1 or 2 additional intercalated tertiary spiral threads between secondary and primary cords on lower part of penultimate whorl.

Aperture narrowly ovate to lens-shaped. Parietal callus thin, smooth and glossy, appressed to body whorl. Columellar folds absent. Outer lip thin. Siphonal canal broad, shorter than aperture, oblique at left-hand side and straight.

Operculum corneous, thin and pale reddish-brown, shape and size corresponding to aperture, with terminal nucleus.

Periostracum thin, olive-green in colour.

Radula (Fig. 79) typical of genus. Central tooth tricuspid, median cusp strongest, occasionally with 1 or 2 small additional denticles situated near middle of cusp. Lateral teeth strongly curved, with 6 or 7 long and pointed cusps mostly of equal size. A small denticle occasionally appears at both ends of lateral tooth.

Range and habitat: Described from Nazca Ridge and from off Valparaiso, Chile. On mud and muddy sand in deep water between 150 and 1200 m.

Remarks: *Aeneator castillai* McLean and Andrade, 1982, a buccinid species, is similar in sculpture and colour, but can be distinguished by the larger size, the broader shape, the more ventricose body whorl, the clearly larger aperture, and finally the buccinid radula.

Fusinus (Chryseofusus) acherusius sp. nov. (Figs. 38-43, 80)

Type material: Holotype (58.6 x 22.6 mm, lv) and one paratype (48.0 x 20.9 mm, lv) in MNHN, 1 paratype RH (52.3 x 21.4 mm, dd).

Type locality: West Madagascar, Mozambique Channel, stn CH126, 17° 50′ S, 43° 07′ E, 1475-1530 m.
Material examined: The live taken holotype and the paratype in MNHN from the type locality.
Madagascar, west Madagascar, Mozambique Channel, 18° 00′ S, 43° 00′ E, 1715-1750 m, 1 dd, paratype RH. – Northwest Madagascar, Mozambique Channel, stn CH131, 13° 46′ S, 47° 33′ E, 1490-1600 m, 1 lv.
South New Caledonia, BIOCAL stn CP27, 23° 06′ S, 166° 26′ E, 1850-1900 m, 1 dd.
Etymology: "acherusius" (Latin, adjective), meaning "from the underworld" and "sombre, dreary".

Description: Shell medium sized (up to 58.6 mm), dirty grey, rather heavy, body whorl short, spire high, consisting of about 8 carinated whorls which are appressed to preceding one. Shoulder slope straight or slightly concave.

Protoconch decollated in all available specimens.

Upper teleoconch whorls with about 12 rather weak axial ribs, which are most prominent at periphery. Interspaces shallow, as broad as ribs. Ribs slightly more numerous (up to 17) on latter whorls, withdrawing from upper suture and becoming simultaneously weaker, gradually fading away towards body whorl. Usually without axial ribs on body whorl.

Four or five strong spiral cords on upper teleoconch whorls. Central one somewhat stronger, forming a distinct carina on all whorls. From early whorls on, 1 fine intercalated secondary thread appears between each pair of stronger primary cords. On body whorl often becoming as strong as primary ones. Spiral sculpture crossed by numerous unequal close-set axial growth lines giving surface the texture of linen.

Aperture elongate, narrow, white to yellowish. Outer lip sharp, simple, finely crenulated. Posterior canal well developed, without internal lirae. Inner lip smooth, without callus and columellar folds. Siphonal canal short, slightly longer than half of aperture length, widely open, strongly curved to the left and slightly curved backwards.

Periostracum thin, light brownish, well-adherent.

Operculum typical of genus, brown coloured, corneous, size and shape corresponding to aperture, with terminal nucleus.

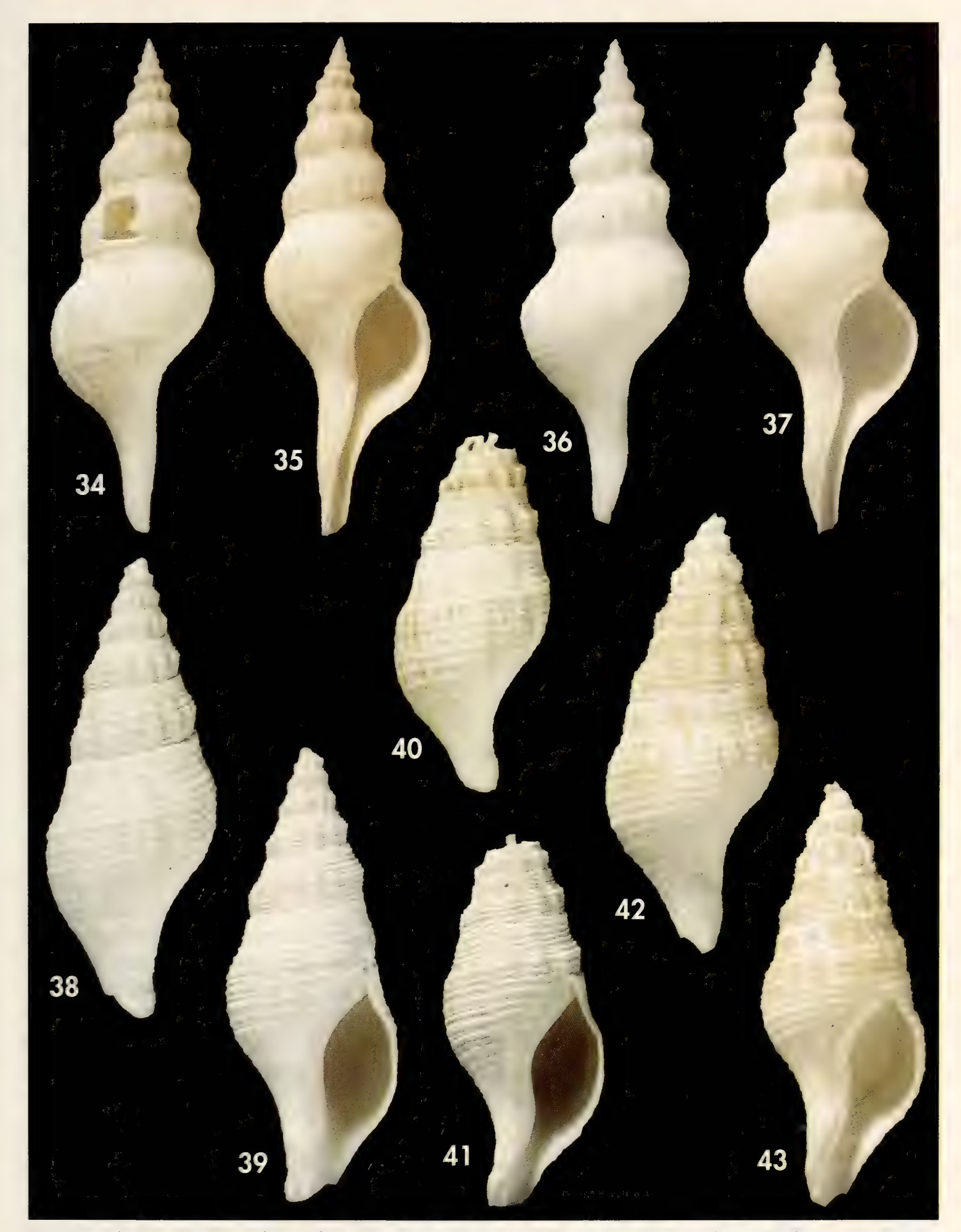
Radula (Fig. 80) fusinid, central tooth tricuspid, somewhat atypical for *Fusinus*, extremely narrow, elongated, with a strong central cusp and 1 rudimentary, reduced, hardly visible small cusp at both sides of the central one. Lateral teeth typical of genus, slightly curved, base broad, with 7 rather short pointed cusps.

Range and habitat: West Madagascar, Mozambique Channel, 1530-1715 m deep. One single record (Figs. 42, 43) from south New Caledonia, 1850-1900 m deep.

Comparison: *F. kazdailisi* from off the Chilean coast most closely resembles *F. acherusius*, but can be separated by having weaker and more numerous axial ribs on upper teleoconch whorls, no axial ribs on penultimate whorl, non-carinated whorls, a narrower and straight siphonal canal, and finally a different radula (central tooth nearly round with 3 well-developed cusps, the central one occasionally with 1 or 2 small additional denticles).

Fusinus (Chryseofusus) artutus sp. nov. (Figs. 44-47, 82)

Type material: Holotype NM L2083 (72.2 x 26.0 mm, dd) in NM, paratype 1 (59.5 x 23.2 mm, lv), B. Rogers.
Type locality: Philippines, Bohol, Panglao, 200 m deep.
Material examined: Holotype and paratype both from the type locality, collected by local fishermen.
Indonesia, Tanimbar Islands, KARUBAR stn CP46, 08° 01′ S, 132° 51′ E, 271-273 m, 1 lv subad.
New Caledonia, BIOCAL stn DW08, 20° 34′ S, 166° 54′ E, 435 m, 1 lv/2 dd juv.
Etymology: Named after the Latin expression "artutus" (adjective), meaning "strongly built" (or "sturdy", "solid", "firm"), remembering the broad and solid shell.



Figures 34-37. *Fusinus (Chryseofusus) jurgeni* Hadorn and Fraussen, 2002. 34, 35: Holotype MNHN, southwest Madagascar, 94.2 mm; 36, 37: Paratype MNHN, southwest Madagascar, Tulear, 83.4 mm. Figures 38-43. *Fusinus (Chryseofusus) acherusius* sp. nov. 38, 39: Holotype MNHN, west Madagascar, Mozambique Channel, 58.6 mm; 40, 41: Paratype MNHN, west Madagascar, Mozambique Channel, 48.0 mm; 42, 43: MNHN, south New Caledonia, 35.5 mm.

Figuras 34-37. Fusinus (Chryseofusus) jurgeni Hadorn y Fraussen, 2002. 34, 35: Holotipo MNHN, SE de Madagascar, 94,2 mm; 36, 37: Paratipo MNHN, SO de Madagascar, Tulear, 83,4 mm. Figuras 38-43. Fusinus (Chryseofusus) acherusius sp. nov. 38, 39: Holotipo MNHN, O de Madagascar, Mozambique Channel, 58,6 mm; 40, 41: Paratipo MNHN, O de Madagascar, Mozambique Channel, 48,0 mm; 42, 43: MNHN, S de Nueva Caledonia, 35,5 mm.

Description: Shell up to 72.2 mm, fusiform, stout, with broad spire angle, 9 or 10 convex, shouldered whorls with slight subsutural concavity. Suture wavy, following axial sculpture of preceding whorl on ribbed upper part of the spire, straight on lower whorls. Spire tip white, latter whorls flesh coloured, inside aperture light brownish or whitish.

Protoconch rather large, white, 1 to 1 1/4 whorls, smooth and glossy, sometimes with axial growth lines on final part, ending in a varix. 1.0 mm in diameter.

Strong, close-set axial ribs on upper teleoconch whorls, traversing from suture to suture. Interspaces narrow and deep. About 9-11 narrow and distinct ribs on upper whorls, suddenly becoming lower and broader, and fading away on penultimate whorl.

Teleoconch begins with 4 strong spiral cords. 2 additional cords appear on second whorl: one immediately below suture, the other just above lower suture. From third whorl on, a fine secondary spiral thread appears between each pair of primary cords, becoming soon as strong as primary ones. In addition very fine intercalated tertiary spirals appear. This fine spiral sculpture is crossed by strong close-set axial growth lines, giving the surface the texture of linen.

Aperture ovate, white or light brownish coloured. Outer lip thin, edge slightly crenulated, inside smooth or inconspicuously lirate. Parietal callus thin, smooth, columellar folds absent. Siphonal canal rather short, about as long as aperture, curved, slightly bending backwards.

Periostracum thin, greenish, well-adherent.

Operculum typically fusinid, reddish-brown, corneous, shape and size corresponding to aperture, with terminal nucleus.

Radula typically fusinid (Fig. 82). Central tooth small, broad, top and both sides concave, base convex, tricuspid, cusps of about equal size, projecting below base. Lateral teeth curved, having 6 or 7 rather small, short, pointed cusps with incurved tips. Small denticle at inner end.

Range and habitat: Philippines, Bohol, 200-540 m deep. One record from Indonesia, Tanimbar Islands, 271-273 m deep, and one record from New Caledonia, 435 m deep.

Comparison: *F. chrysodomoides* has a less constricted suture, a white to brownish shell, coarser and less numerous axial ribs on upper whorls, and a finer, more close-set spiral sculpture.

F. graciliformis has a more elegant shell with elongate spire, a larger adult size, less ventricose, less convex and longer whorls, and has a weaker spiral sculpture with a larger number of intercalated fine threads on body whorl.

Fusinus (Chryseofusus) dapsilis sp. nov. (Figs. 48, 49)

Type material: Holotype (74.1 x 29.2 mm, dd) in MNHN.

Type locality: Vietnam, deep water, not accompanied by detailed data.

Material examined: The holotype is the only specimen known, and originates from material traded by Russian collectors in the late 1980s – early 1990s.

Etymology: Named after the Latin expression "dapsilis" (adjective), meaning "precious" "expensive", remembering the golden colour.

Description: Shell 74.1 mm, reddish-brown, fusiform, thin, light in weight but solid. Whorls convex and ventricose, surrounded by distinct subsutural concavity.

Protoconch and spire tip broken leaving 6 1/4 remaining whorls. Original number of teleoconch whorls 9 or 10 by estimation.

Upper part of spire covered with 10 or 11 rounded, dense, relatively strong axial ribs, extending from suture to suture, suddenly fading away on antepenultimate whorl. Last 3 whorls smooth, except for

strong, curved axial growth lines crossed by weak close-set spiral threads, giving surface the texture of linen.

Four rather strong spiral cords on uppermost remaining whorl; subsutural cord somewhat weaker. On next whorl, a fine intercalated secondary thread appears between each pair of primary cords, becoming as strong as primary ones on antepenultimate whorl. Up to 3 tertiary, clearly finer intercalated threads appear between the strong primary and secondary cords on penultimate and body whorl. Spiral sculpture crossed by strong growth lines, giving the spirals a pearled appearance.

Aperture rather large, light purplish coloured. Outer lip simple, thin, edge minutely crenulated; interior side smooth. Parietal wall covered with a thin, glossy and smooth callus, somewhat extending outside aperture. Columellar folds absent. Siphonal canal conspicuously short, broad, open and strongly curved.

Periostracum, protoconch and radula unknown.

Range and habitat: Only known from the South China Sea, off Vietnam. No precise information about locality and habitat available.

Comparison: *F. chrysodomoides* differs from *F. dapsilis* by the heavier shell, the broader and less close-set axial ribs and the longer siphonal canal.

F. bradneri has a smaller adult size, is more elegant and has a more elongate spire, a longer and narrower siphonal canal, and the inside of the aperture is strongly lirate. Moreover, the axial sculpture on upper teleoconch whorls consists of strong, broad axial ribs, and the stronger spiral cords are reddish-brown in colour.

Fusinus (Chryseofusus) riscus sp. nov. (Figs. 50-53, 83)

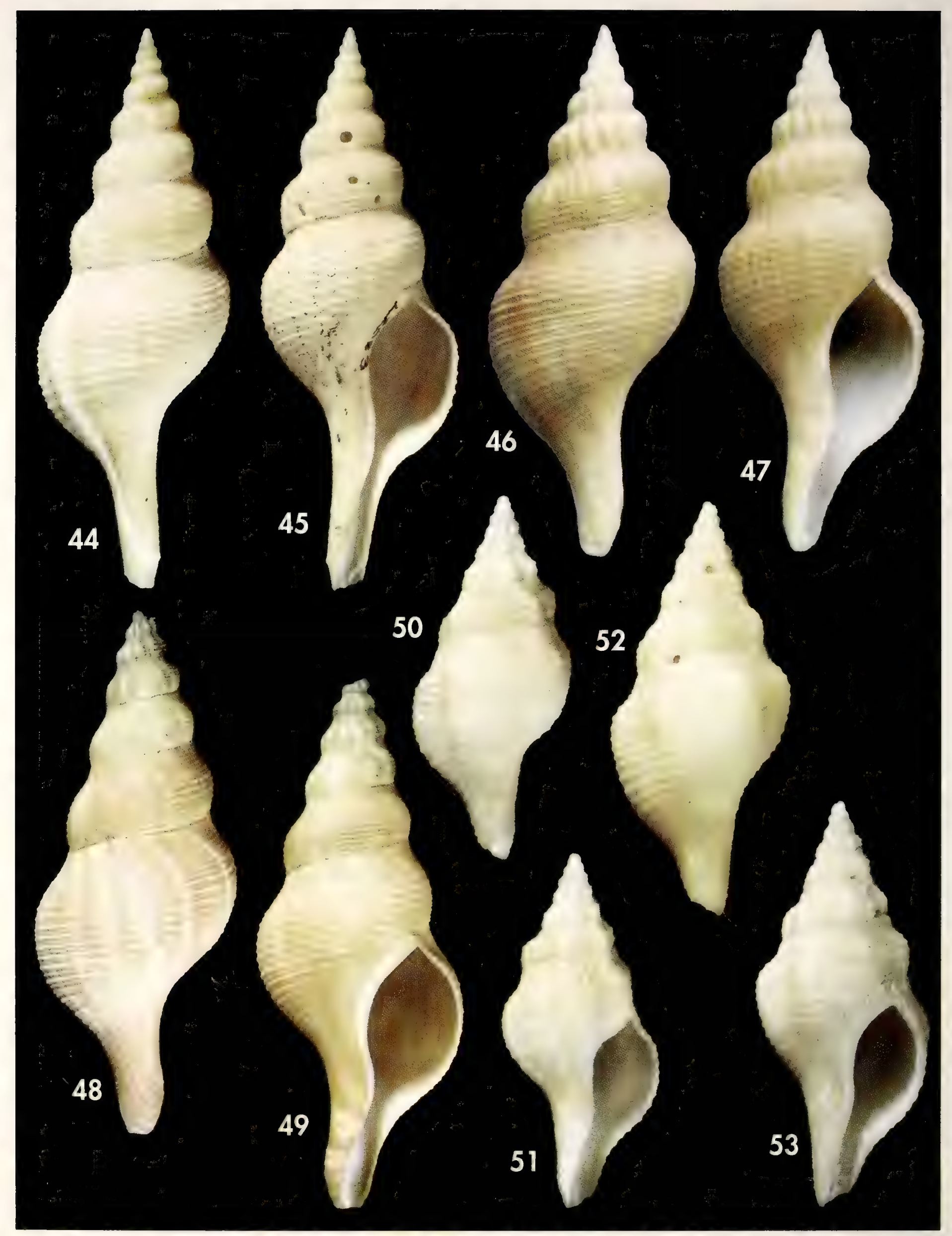
Type material: Holotype (19.1 x 8.3 mm, lv subad) and one paratype (18.9 x 8.9 mm, lv) in MNHN, 4 paratypes in AMS C.205150 (21.5 x 9.7 mm, dd), NMNZ M.273192 (19.4 x 8.4 mm, dd), RH (21.4 x 9.3 mm, lv subad), KF (19.3 x 8.3 mm, lv subad).
Type locality: South New Caledonia, Norfolk Ridge, BATHUS 3 stn DW818, 23° 44′ S, 168° 16′ E, 394-401 m.
Material examined: The live collected holotype, the 5 paratypes, and 8 specimens (2 dd/3 lv subad/3 dd juv) from the type locality.
South New Caledonia, Norfolk Ridge, BATHUS 3 stn DW817, 23° 42′ S, 168° 16′ E, 405-410 m, 11 dd/5 dd juv/3 lv/2 lv juv. – South New Caledonia, BERYX 11 stn CP21, 24° 44′ S, 168° 07′ E, 430-450 m, 2 dd.
Etymology: The name is derived from the Latin "riscus" (noun, masculine), meaning a rotan box. *F. riscus* resembles a rotan box in surface sculpture (fine spiral sculpture crossed by strong growth lines giving surface the texture of linen).

Description: Shell small for genus (up to 21.5 mm), fusiform, thick, whitish to yellowish, consisting of 7 or 8 convex, slightly carinated whorls, appressed to preceding whorl, surrounded by a distinct subsutural concavity. Suture wavy, inconspicuous.

Protoconch consisting of 1 whorl, white, transparent, glossy, smooth, final part (about $^{1}/_{4}$ whorl) with some very fine axial growth lines and 2 or 3 weak spiral threads; transition to teleoconch indistinct. 0.6-0.8 mm in diameter.

Axial sculpture consists of broad, low knobs on all whorls, separated by wide and low interspaces. On upper teleoconch whorls 7 or 8 ribs traversing from suture to suture, on latter whorls 5 or 6 shorter ribs abapically prominent, often somewhat irregular on body whorl.

Teleoconch begins with 4 spiral cords, abapical ones clearly stronger. On fourth or fifth teleoconch whorl, a fifth strong spiral cord appears just above lower suture, stronger when crossing axial knobs and weak in interspaces. Number of spirals increasing by intercalation on latter whorls, secondary ones becoming as strong as primary ones on penultimate and body whorl. On body whorl fine ter-



Figures 44-47. *Fusinus (Chryseofusus) artutus* sp. nov. 44, 45: Holotype NM L2083, Philippines, Bohol, Panglao, 72.2 mm; 46, 47: Paratype B. Rogers, Philippines, Bohol, Panglao, 59.5 mm. Figures 48, 49. *Fusinus (Chryseofusus) dapsilis* sp. nov., Holotype MNHN, Vietnam, 74.1 mm. Figures 50-53. *Fusinus (Chryseofusus) riscus* sp. nov. 50, 51: Holotype MNHN, New Caledonia, Norfolk Ridge, 19.1 mm; 52, 53: MNHN, New Caledonia, Norfolk Ridge, 24.8 mm.

Figuras 44-47. Fusinus (Chryseofusus) artutus *sp. nov. 44, 45: Holotipo NM L2083, Filipinas, Bohol, Panglao, 72,2 mm; 46, 47: Paratipo B. Rogers, Filipinas, Bohol, Panglao, 59,5 mm. Figuras 48, 49.* Fusinus (Chryseofusus) dapsilis *sp. nov., Holotipo MNHN, Vietnam, 74,1 mm. Figuras 50-53.* Fusinus (Chryseofusus) riscus *sp. nov. 50, 51: Holotipo MNHN, Nueva Caledonia, Norfolk Ridge, 19,1 mm; 52, 53: MNHN, Nueva Caledonia, Norfolk Ridge, 24,8 mm.*



Figures 54-57. *Fusinus (Chryseofusus) cadus* sp. nov. 54, 55: Holotype MNHN, south New Caledonia, 35.5 mm; 56, 57: MNHN, south New Caledonia, 30.5 mm. Figures 58-61. *Fusinus (Chryseofusus) alisae* sp. nov. 58, 59: Holotype MNHN, north New Caledonia, 29.6 mm; 60, 61: Paratype MNHN, New Caledonia, 27.5 mm. Figures 62-65. *Fusinus (Chryseofusus) scissus* sp. nov. 62, 63: Holotype MNHN, south New Caledonia, 33.0 mm; 64, 65: Paratype MNHN, south New Caledonia, 31.1 mm. *Figuras 54-57.* Fusinus (Chryseofusus) cadus *sp. nov. 54, 55: Holotipo MNHN, S de Nueva Caledonia, 35,5 mm; 56, 57: MNHN, S de Nueva Caledonia, 30,5 mm. Figuras 58-61.* Fusinus (Chryseofusus) alisae *sp. nov. 58, 59: Holotipo MNHN, N de Nueva Caledonia, 29,6 mm; 60, 61: Paratipo MNHN, Nueva Caledonia, 27,5 mm. Figuras 62-65.* Fusinus (Chryseofusus) scissus *sp. nov. 62, 63: Holotipo MNHN, S de Nueva Caledonia, 33,0 mm; 64, 65: Paratipo MNHN, S de Nueva Caledonia, 31,1 mm.*

tiary threads appear at both sides of secondary spirals. Spiral sculpture crossed by conspicuously strong growth lines giving surface the texture of linen.

Aperture small, ovate, white coloured. Outer lip slightly crenulated, simple. Conspicuously strong, broad internal lirae. Parietal callus appressed, smooth, columellar folds absent. Siphonal canal shorter than aperture length, straight, widely opened. Periostracum light brownish, rather thick.

Operculum brownish, typical of genus, shape and size corresponding to aperture, with terminal nucleus.

Radula typical of *Fusinus* (Fig. 83). Central tooth large, elongate, almost oblong with slightly concave sides, tricuspid. All 3 cusps conspicuously strong and pointed, clearly projecting below base. Central cusp the strongest. Lateral teeth curved, 4-6 strong, long and pointed cusps with incurved tips. At both ends with a small pointed denticle.

Range and habitat: Southern New Caledonia, between 401 and 430 m deep.

Comparison: *F. cadus* and *F. alisae*, both described later in this paper, have a larger adult size, clearly narrower and more axial ribs on upper whorls, and usually a ribless penultimate and body whorl.

Fusinus (Chryseofusus) cadus sp. nov. (Figs. 54-57, 84)

Type material: Holotype (35.5 x 13.4 mm, dd) and 1 paratype (22.3 x 8.9 mm, lv juv) in MNHN, 4 paratypes in AMS C.205151 (26.9 x 10.3 mm, dd subad), NMNZ M.273193 (25.7 x 11.0 mm, dd), RH (23.9 x 9.8 mm, lv subad), KF (19.8 x 8.0 mm, dd juv).
Type locality: South New Caledonia, BERYX 11 stn DW27, 23° 37′ S, 167° 41′ E, 460-470 m.
Material examined: The holotype, 1 paratype MNHN and 6 specimens (dd) from the type locality, all in MNHN.
North New Caledonia, MUSORSTOM 4 stn DW162, 18° 35′ S, 163° 10′ E, 525 m, 1 dd juv. – BATHUS 4 stn DW908, 18° 58′ S, 163° 11′ E, 502-527 m, 1 dd.
South New Caledonia, BERYX 11 stn DW38, 23° 38′ S, 167° 39′ E, 550-690 m, 5 dd/1 lv subad/1 dd juv; stn DW39, 23° 37′ S, 167° 40′ E, 490-500 m, 2 dd juv. – SMIB 3 stn DW12, 23° 38′ S, 167° 42′ E, 470 m, 2 dd. – BIOCAL stn DW33, 23° 10′ S, 167° 10′ E, 675-680 m, 1 lv juv/2 dd juv; stn CP52, 23° 06′ S, 167° 47′ E, 540-600 m, 1 dd subad, paratype AMS C.205151. – CHALCAL 2 stn DW76, 23° 41′ S, 167° 45′ E, 470 m, 2 dd juv/1 lv subad, paratypes RH and KF. – MUSORSTOM 4 stn DW221, 22° 59′ S, 167° 37′ E, 535-560 m, 1 dd juv; stn DW229, 22° 51′ S, 167° 13′ E, 445-460 m, 1 dd, paratype NMNZ M.273193.
Etymology: The name is derived from the Latin "cadus" (noun, masculine), meaning a small terracotta bottle. *F. cadus*, small and with subsutural concavity, also resembles pottery in colour.

Description: Shell small (up to 35.5 mm), whitish to light brownish, consisting of 8 whorls. Whorls convex, with slight subsutural concavity. Suture indistinct.

Protoconch porcellaneous white, swollen, smooth and glossy, consisting of 1 whorl. Final part (about 1/4 whorl) sometimes with some fine axial riblets. 0.7-0.9 mm in diameter.

On upper teleoconch whorls, 8 or 9 strong, broad, low axial ribs, traversing from suture to suture, somewhat narrower at upper end. Interspaces half as wide as the axial ribs. Axial sculpture suddenly fading out on antepenultimate or penultimate whorl.

Four strong spiral cords on upper teleoconch whorls. From third whorl on, a fine spiral thread appears between primary ones. On fifth whorl, up to 3 fine intercalated tertiary spirals appear and secondary spirals become as broad as the primary ones. Spiral sculpture weak, crossed by numerous well-visible close-set growth lines giving surface the texture of linen.

Aperture narrowly ovate, white, pointed at both ends, with numerous weak internal lirae. Outer lip thin, finely crenulated. Parietal callus thin, smooth, appressed, columellar folds absent. Siphonal canal slightly curved, somewhat shorter than aperture.

Periostracum light brownish, thick.

Operculum typical of genus, corneous, brown, shape and size corresponding to aperture, with terminal nucleus.

Radula typically fusinid (Fig. 84), central tooth rather large, almost ovate (top and base convex, both sides straight or slightly concave), with 3 prominent cusps projecting below base. Central cusp somewhat stronger than the others. Lateral teeth curved, with 6 prominent long cusps with incurved tips. Outermost one the broadest and strongest. With a small denticle at both ends.

Range and habitat: From north New Caledonia to south New Caledonia (18° 35′ S, 163° 10′ E to 23° 41′ S, 167° 47′ E), between 460 and 675 m deep.

Comparison: *F. riscus* has a smaller adult size, less numerous and much broader axial ribs with broad interspaces on upper whorls, and has the penultimate and body whorl axially ribbed.

F. alisae is similar in size and sculpture, but has a larger number of narrower axial ribs, more convex whorls, the upper whorls increase their diameter much more rapidly, and different radula morphology (lateral teeth with more and clearly shorter cusps, and the central tooth has a narrower, concave top and more concave sides and oblique cusps at both sides of the central one).

Juvenile specimens of *F. wareni* are also similar in shape and sculpture, but the whorl diameter increases more rapidly and the spire is less extended. *F. wareni* has more axial ribs per whorl, adult shells are clearly larger in size and have more whorls.

Fusinus (Chryseofusus) alisae sp. nov. (Figs. 58-61, 85)

Type material: Holotype (29.6 x 12.1 mm, dd) and 1 paratype (27.5 x 11.8 mm, dd) in MNHN, 4 paratypes in AMS C.205152 (26.4 x 11.0 mm, dd), NMNZ M.273194 (27.4 x 12.5 mm, dd), RH (35.5 x 15.5 mm, dd), KF (20.8 x 9.6 mm, dd).

Type locality: North New Caledonia, BATHUS 4 stn DW927, 18° 56′ S, 163° 22′ E, 444-452 m.

Material examined: The holotype, 1 paratype MNHN and 14 specimens (9 dd juv/5 lv juv) from the type locality.

Coral Sea, Chesterfield Islands, MUSORSTOM 5 stn 361, 19° 53′ S, 158° 38′ E, 400 m, 3 dd juv; stn 378, 19° 54′ S, 158° 38′ E, 355 m, 2 dd juv; stn 379, 19° 53′ S, 158° 40′ E, 370-400 m, 1 dd juv.

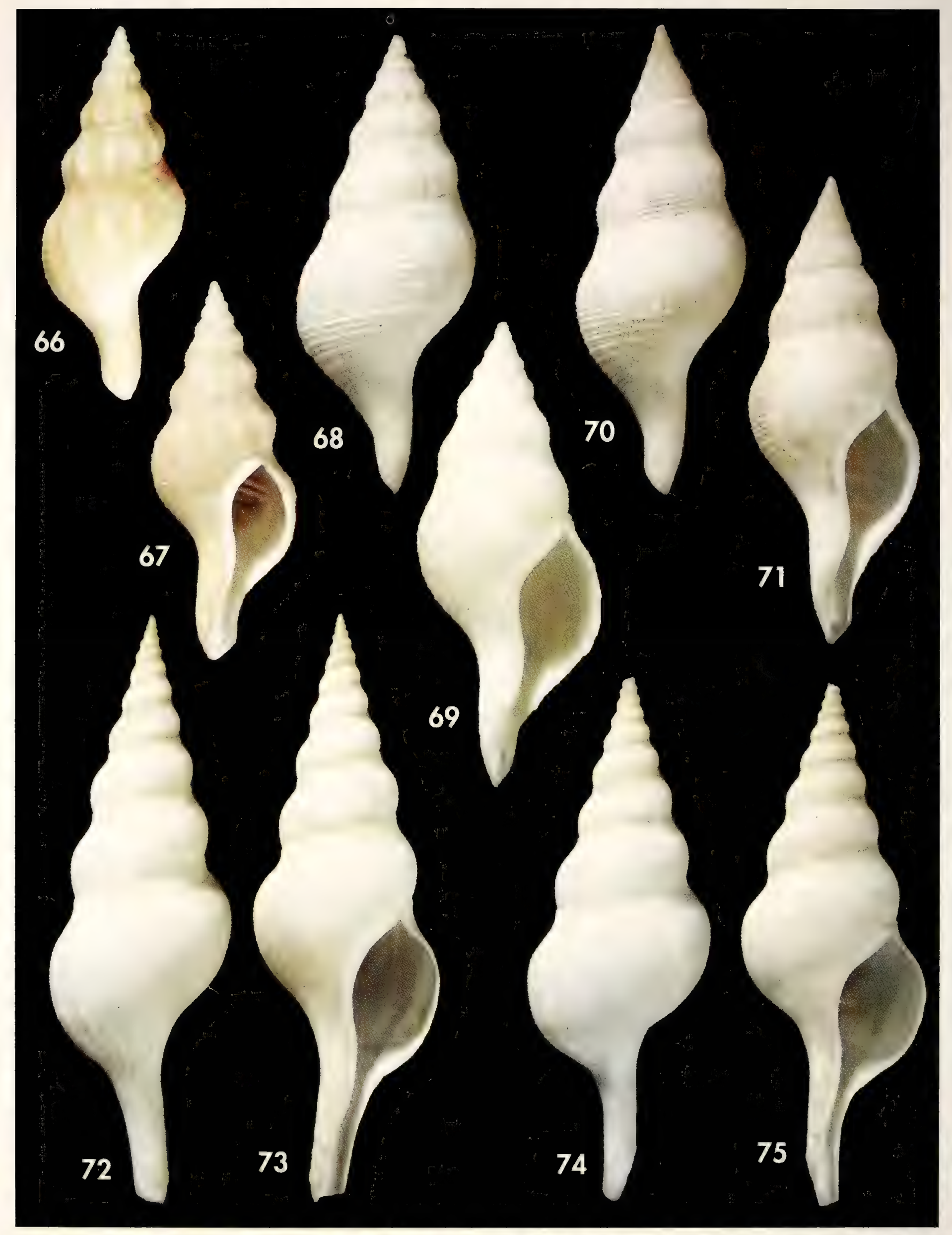
North New Caledonia, SMIB 6 stn DW118, 18° 58′ S, 163° 26′ E, 290-300 m, 1 dd, paratype RH; stn DW119, 18° 59′ S, 163° 26′ E, 295-305 m, 1 dd, paratype NMNZ M.273194; stn DW121, 18° 58′ S, 163° 26′ E, 315 m, 1 lv/1 dd/1 dd juv; stn DW122, 18° 58′ S, 163° 25′ E, 325-330 m, 2 lv subad; stn DW123, 18° 57′ S, 163° 25′ E, 330-360 m, 1 dd, paratype AMS C.205152. – BATHUS 4 stn DW923, 18° 52′ S, 163° 24′ E, 470-502 m, 3 dd juv; stn DW924, 18° 55′ S, 163° 24′ E, 344-360 m, 3 dd; stn DW925, 18° 55′ S, 163° 24′ E, 370-405 m, 4 dd juv; stn DW926, 18° 57′ S, 163° 25′ E, 325-330 m, 1 dd/2 dd juv; stn CP928, 18° 55′ S, 163° 24′ E, 420-452 m, 1 dd/1 dd juv; stn DW931, 18° 55′ S, 163° 24′ E, 360-377 m, 1 lv juv/3 dd; stn DW940, 19° 00′ S, 163° 26′ E, 305 m, 1 dd, paratype KF. – MUSORSTOM 4 stn CP194, 18° 53′ S, 163° 22′ E, 545 m, 3 dd juv; stn DW181, 18° 57′ S, 163° 22′ E, 350 m, 4 dd juv; stn DW196, 18° 55′ S, 163° 24′ E, 450 m, 2 dd juv.

Etymology: Named after the French research vessel "*Alis*", which collected most of the known specimens during the cruises BATHUS 4 and SMIB 6.

Description: Shell small (up to 35.5 mm), whitish to light brownish, fusiform, 7 or 8 convex whorls with subsutural concavity. Upper whorls slightly bicarinate. Diameter of upper whorls increasing more rapidly than lower ones.

Protoconch whitish, consisting of 1 $^{1}/_{4}$ whorls. Upper part smooth and glossy, last part (about $^{1}/_{4}$ to $^{1}/_{2}$ whorl) sculptured with some narrow but strong axial riblets. 0.7-1.0 mm in diameter.

Axial ribs traversing from suture to suture on upper whorls, withdrawing from upper suture on latter whorls. 9-12 rather weak, narrow ribs on 2 uppermost teleoconch whorls, separated by conspicuously narrow interspaces. 10-14



Figures 66, 67. *Fusinus (Chryseofusus) scissus* sp. nov., MNHN, south New Caledonia, 32.1 mm. Figures 68-71. *Fusinus (Chryseofusus) wareni* sp. nov. 68, 69: Holotype MNHN, New Caledonia, 59.5 mm; 70, 71: Paratype MNHN, New Caledonia, 50.0 mm. Figures 72-75. *Fusinus (Chryseofusus) westralis* sp. nov., northwest Australia, Rottnest Island. 72, 73: Holotype WAM S10876, 114.4 mm; 74, 75: Paratype MNHN, 113.3 mm.

Figuras 66, 67. Fusinus (Chryseofusus) scissus *sp. nov., MNHN, S de Nueva Caledonia, 32,1 mm. Figuras 68-71.* Fusinus (Chryseofusus) wareni *sp. nov. 68, 69: Holotipo MNHN, Nueva Caledonia, 59,5 mm; 70, 71: Paratipo MNHN, Nueva Caledonia, 50,0 mm. Figuras 72-75.* Fusinus (Chryseofusus) westralis *sp. nov., NO de Australia, Rottnest Island. 72, 73: Holotipo WAM S10876, 114,4 mm; 74, 75: Paratipo MNHN, 113.3 mm.*

ribs on following 2 or 3 whorls, latter whorls usually without ribs. Large adult specimens sometimes with conspicuously strong axial knobs on body whorl.

Teleoconch begins with 4 spiral cords. 2 adapical ones clearly stronger from beginning and forming a weak, inconspicuous double keel on upper whorls, fading away on latter whorls. From second or third postnuclear whorl on, a fine intercalated thread appears between each pair of primary cords. Number of fine threads increasing up to 2 by intercalation on latter whorls. Rather weak spiral sculpture crossed by prominent axial growth lines giving surface the texture of linen.

Aperture ovate, whitish, pointed at both ends. Outer lip slightly crenulated, simple. About 18 rather fine internal lirae. Inner lip smooth, parietal callus thin, columellar folds absent. Siphonal canal shorter than aperture, slightly curved.

Periostracum light brown, rather thin.

Operculum corneous, brownish, typical of genus, shape and size corresponding to aperture, with terminal nucleus.

Radula typical of genus (Fig. 85). Central tooth small, short. Base convex, broad, with 3 prominent cusps of about equal size projecting below base; top narrow, concave; both sides strongly convex. Lateral teeth curved, having 6 or 7 short pointed cusps of about equal size and a small pointed denticle at both ends.

Range and habitat: North of New Caledonia and Coral Sea, Chesterfield Islands, between 300 and 545 m deep.

Comparison: *F. riscus* differs in being smaller, having less convex whorls, a clearly smaller number of much broader axial ribs with broader interspaces on upper whorls, an axially ribbed penultimate and body whorl and differences in radula morphology (clearly larger, elongate central tooth, a smaller number of much longer cusps on lateral teeth) and a different protoconch (only one whorl, sculptured with fine axial growth lines and 2 or 3 weak spiral threads on final part).

F. cadus differs in the less numerous and broader axial ribs, less convex whorls, the upper whorls increasing in diameter slower than in *F. alisae*, the last part of the protoconch is smooth or has some fine axial riblets, and has a different radula morphology (lateral teeth with less numerous but much longer cusps).

Fusinus (Chryseofusus) scissus sp. nov. (Figs. 62-67, 88)

Type material: Holotype (33.0 x 14.5 mm, lv) and 2 paratypes (31.1 x 13.6 mm, lv; 33.4 x 15.9 mm, dd, siphonal canal broken) in MNHN, and 4 paratypes in AMS C.205153 (31.9 x 14.7 mm, lv), NMNZ M.273195 (29.9 x 13.8 mm, lv), RH (33.4 x 14.1 mm, lv), KF (27.2 x 11.4 mm, lv).
Type locality: South New Caledonia, SMIB 3 stn DW24, 22° 59′ S, 167° 21′ E, 535 m.
Material examined: The live taken holotype and all the paratypes from the type locality.
South New Caledonia, SMIB 1 stn DW2, 22° 52′ S, 167° 13′ E, 415 m, 1 lv/1 lv juv; stn DW7, 22° 56′ S, 167° 16′ E, 500 m, 1 dd juv. – SMIB 2 stn DW3, 22° 56′ S, 167° 15′ E, 412-428 m, 1 dd; stn DW4, 22° 53′ S, 167° 13′ E, 410-417 m, 1 dd juv; stn DW5, 22° 56′ S, 167° 14′ E, 398-410 m, 2 dd juv; stn DW6, 22° 56′ S, 167° 16′ E, 442-460 m, 1 dd juv; stn DW9, 22° 54′ S, 167° 15′ E, 475-500 m, 2 lv juv; stn DW10, 22° 55′ S, 167° 16′ E, 490-495 m, 3 lv/7 dd; stn DW17, 22° 55′ S, 167° 15′ E, 428-448 m, 1 lv; stn DW18b, 22° 58′ S, 167° 20′ E, 530-535 m, 3 lv/6 dd; stn DC26, 22° 59′ S, 167° 23′ E, 500-535 m, 1 lv/1 dd. – SMIB 3 stn DW21, 22° 59′ S, 167° 19′ E, 525 m, 1 lv/1 dd; stn DW22, 23° 03′ S, 167° 19′ E, 503 m, 3 lv juv/1 dd; stn DW23, 22° 58′ S, 167° 20′ E, 530 m, 1 lv/1 dd; stn DW26, 22° 55′ S, 167° 16′ E, 450 m, 1 dd juv. – SMIB 4 stn DW58, 23° 00′ S, 167° 24′ E, 480-560 m, 2 lv/1 dd; stn DW61, 23° 00′ S, 167° 22′ E, 520-550 m, 1 lv/1 dd; stn DW62, 23° 00′ S, 167° 22′ E, 490-540 m, 1 lv; stn DW63, 22° 59′ S, 167° 21′ E, 580 m, 1 dd; stn DW65, 22° 55′ S, 167° 15′ E, 400-420 m, 1 dd. – MUSORSTOM 4 stn CP214, 22° 54′ S, 167° 14′ E, 425-440 m, 1 dd; stn CP216, 22° 59′ S, 167° 22′ E, 490-515 m, 1 dd juv; stn DW222, 22° 58′ S, 167° 33′ E, 410-440 m, 1 dd. – BERYX 11 stn CP22, 24° 44′ S, 168° 07′ E, 490-510 m, 1 dd. – BIOCAL stn DW44, 22° 47′ S, 167° 14′ E, 440-450 m, 2 dd/22 dd juv; stn DW46, 22° 53′ S, 167° 17′ E, 570-610 m, 20 dd juv/4 lv juv. – BATHUS 2 stn DW719, 22° 48′ S, 167° 16′ E,

444-445 m, 2 lv/1 dd/15 dd juv; stn DW720, 22° 52′ S, 167° 16′ E, 530-541 m, 3 lv/24 dd/9 dd juv; stn DW721, 22° 54′ S, 167° 17′ E, 525-547 m, 3 lv/12 dd/26 dd juv/6 lv juv.
Ile des Pins, southeast Récif sud, SMIB 8 stns DW193-196, 22° 59′ S-23° 00′ S, 168° 21′ E-168° 23′ E, 491-558 m, 16 dd/18 dd juv; stn DW201, 22° 59′ S, 168° 21′ E, 500-504 m, 2 dd/1 dd juv.
Norfolk Ridge, SMIB 8 stn DW200, 24° 00′ S, 168° 21′ E, 514-525 m, 2 dd.
New Caledonia, 500 m, by local fisherman, 2 lv/3 dd, RH.
Etymology: "scissus" (Latin, adjective) means "wrinkled", describing the weak and close-set axial folds on all whorls.

Description: Shell small (up to 33.4 mm), fusiform, body whorl inflated, 8 whorls. Whorls convex, unkeeled or with an inconspicuous double keel, body whorl conspicuously ventricose. Colour uniformly white.

Protoconch large, 1.0 mm in diameter, smooth, whitish, consisting of 1$^1/_4$ whorls; final part (about $^1/_4$ whorl) sculptured with some fine axial riblets traversing from suture to suture. Ending in an indistinct varix.

Eleven to thirteen inconspicuous, weak, close-set axial folds on all whorls, traversing from suture to suture on upper whorls. Ribs withdrawing from upper suture on body whorl, becoming somewhat stronger, forming more or less prominent axial knobs at periphery.

Teleoconch beginning with 4 or 5 rather weak spiral cords. From second or third whorl on, fine intercalated secondary spiral threads appear between primary cords. Number increasing to 6 on latter whorls. 2 primary cords at periphery often somewhat stronger than others, forming sometimes an indistinct double keel.

Aperture large, ovate, pinched at upper end, white or cream coloured, often light brownish or purplish along edge on inner side of outer lip. Outer lip simple, slightly crenulated; inner side ornamented with close-set white lirae. Parietal callus thin, appressed to parietal wall, smooth and glossy. Columellar folds absent. Siphonal canal conspicuously short, broad, curved and widely open. Outer side sculptured with some rather weak spiral cords and up to 3 intercalated fine threads.

Periostracum straw coloured, thin.

Operculum typical of genus, corneous, light brown, shape and size corresponding to aperture, outer side sculptured with fine concentric growth lines, with terminal nucleus.

Radula typical of genus (Fig. 88). Central tooth tricuspid, middle cusp strongly developed, long and straight; cusps at both sides shorter with incurved tips. All cusps clearly project below base. Lateral teeth broad, curved, consisting of 5 or 6 strong, long, pointed cusps with incurved tips and with small denticle at both ends. Outermost cusp strongest and broadest.

Range and habitat: Only known from southern New Caledonia, 410-580 m deep.

Comparison: *F. scissus* can be distinguished from the other small southwest Pacific species *F. cadus, F. alisae* and *F. riscus* by the somewhat larger adult size, the large, ventricose body whorl, the larger aperture and the axially ribbed body whorl.

Manaria insularis Okutani, 1968, a species of uncertain generic position (see discussion under *F. chrysodomoides*), most closely resembles *F. scissus* in shape and size, but differs in having a light brown shell, a smaller number of whorls, indistinct axial ribs on body whorl, and by the clearly different spiral sculpture (close-set, strong, raised spiral cords, strong on the top of ribs, obscure in the interspaces, and by the presence of only one intercalated fine thread on penultimate and body whorl).

Fusinus (Chryseofusus) wareni sp. nov. (Figs. 68-71)

Type material: Holotype (59.5 x 22.3 mm, dd) and 1 paratype in MNHN (50.0 x 20.1 mm, dd).
Type locality: New Caledonia, MUSORSTOM 4 stn CP170, 18° 57′ S, 163° 13′ E, 480 m.

Material examined: The holotype in MNHN.
New Caledonia, MUSORSTOM 4 stn CC201, 18° 56′ S, 163° 14′ E, 490 m, 1 dd, paratype MNHN.
Loyality Ridge, BATHUS 3 stn DW794, 23° 48′ S, 169° 49′ E, 751-755 m, 1 fragment.
Tonga Islands, seamount south of Eua, BORDAU 2 stn DW1617, 23° 03′ S, 175° 53′ W, 483-531 m, 1 dd/1 dd juv.
Etymology: This species is named to honour Anders Warén (SMNH) for his contributions to malacology. The preparation of the radulae and SEM illustrations in this paper are his work.

Description: Shell medium sized (up to 59.5 mm), fusiform, uniformly whitish or brownish, consisting of about 9 rounded teleoconch whorls with slight subsutural concavity. Suture indistinct, whorls appressed to preceding one.

Protoconch white, bulbous, glossy, smooth, consisting of 1 1/4 whorls, ending in a varix. Diameter about 0.9-1.0 mm.

Uppermost 4 or 5 teleoconch whorls rather weakly axially ribbed. 10-12 low, broad ribs with narrow interspaces, reaching from suture to suture on first 3 whorls, withdrawing from upper suture on fourth or fifth postnuclear whorl. Lower whorls without axial ribs. All whorls ornamented with well-visible, close-set, curved growth lines, crossing the weak spiral cords and giving surface the texture of linen.

Teleoconch beginning with 4 or 5 spiral cords, adapically more prominent compared to upper ones. From third whorl on, a fine secondary spiral thread appears between each pair of primary cords. From fifth whorl on, 1 tertiary fine thread appears at both sides of secondary ones. From sixth whorl on, the secondary ones become as strong as primary ones. 2 or 3 fine intercalated spiral threads between stronger cords on body whorl.

Aperture ovate, pointed at both ends, white or flesh coloured, inner lip smooth. Parietal wall covered with a thin callus, becoming well-developed on columella. Columellar folds absent. Outer lip simple. Internal side sculptured with about 18-20 elongate, irregular and rather strong denticles. Siphonal canal about as long as aperture, strongly curved, rather narrow, open, tapering anteriorly. Outer side sculptured with close-set spiral cords and up to 3 fine intercalated spiral threads.

Periostracum, operculum and radula unknown.

Range and habitat: New Caledonia and Tonga Islands, between 480 and 751 m deep.

Comparison: *F. kazdailisi* is most similar to *F. wareni* in shape and sculpture but differs in having a somewhat smaller adult size, a dirty greyish to brown or pale reddish-brown colour, less numerous whorls, stronger and more pronounced axial ribs with more distinct interspaces, a smaller number of somewhat stronger spiral cords which are intercalated by 3-6 fine spiral threads on body whorl, and finally in having a broad and straight siphonal canal which is oblique to the left side.

F. acherusius has a heavier shell, carinated upper whorls, numerous pronounced axial ribs on most whorls, a rough spiral sculpture, rough growth lines of unequal strength, and a broader and shorter siphonal canal.

F. alisae has a smaller adult size, a whitish to light brownish colour, broader upper postnuclear whorls, a usually bicarinate profile of the upper whorls, a smaller protoconch, a subsutural concavity which is often more prominent, and an often larger number of axially ribbed whorls.

F. cadus also differs in having a clearly smaller adult size, a whitish to light brownish colour, a smaller protoconch with a smaller diameter, in having a less prominent subsutural concavity, a more slender shell, and a larger number of axially ribbed whorls.

F. artutus is similar in sculpture, but has a larger adult size, more convex whorls, a longer spire, a more constricted suture, a deeper subsutural concavity, and a longer siphonal canal.

Fusinus (Chryseofusus) westralis sp. nov. (Figs. 72-75)

Siphonofusus chrysodomoides (Schepman, 1911). – KOSUGE (1985: 59, pl. 23, fig. 7); WILSON (1994: 66, pl. 12, figs. 7a-b).
Fusinus chrysodomoides (Schepman, 1911). – HADORN AND FRAUSSEN (1999: pl. 3, figs. 17-18).

Type material: Holotype (114.4 x 36.2 mm, lv) in WAM S10876. 8 paratypes in MNHN (113.3 x 40.6 mm, lv), AMS C.205154 (99.3 x 34.0 mm, lv), NMNZ M.273196 (86.6 x 31.6 mm, lv), USNM (81.2 x 29.3 mm, lv), ZMA Moll. 4.03.005 (93.6 x 32.1 mm, lv), KF 3201 (123.5 x 40.2 mm, lv), RH (123.6 x 42.6 mm, lv), B. Rogers (114.1 x 38.4 mm, lv).
Type locality: Northwest Australia, Rottnest Island, 400-500 m deep.
Material examined: The live collected holotype and 8 paratypes from the type locality. Northwest Australia, off Rottnest Island, 400-500 m deep, collected by commercial fishing boats, 33 lv, KF 3203; 1 lv, RH. – Off Port Hedland, deep water, 1 lv, KF3201; 1 lv, KF3202; 5 lv, RH.
Etymology: Named after Western Australia, which is the species present range. Also to remember *Perotrochus westralis* (Whitehead, 1987), a sympatric species.

Description: Shell large (up to 140 mm), light, thin, uniformly white, shape fusiform. 11-13 ventricose, unkeeled whorls, with wide subsutural concavity.

Protoconch white, glossy, consisting of 1 whorl, ending in a weak varix. Surface of protoconch slightly eroded and therefore no sculpture visible. 0.9 mm in diameter.

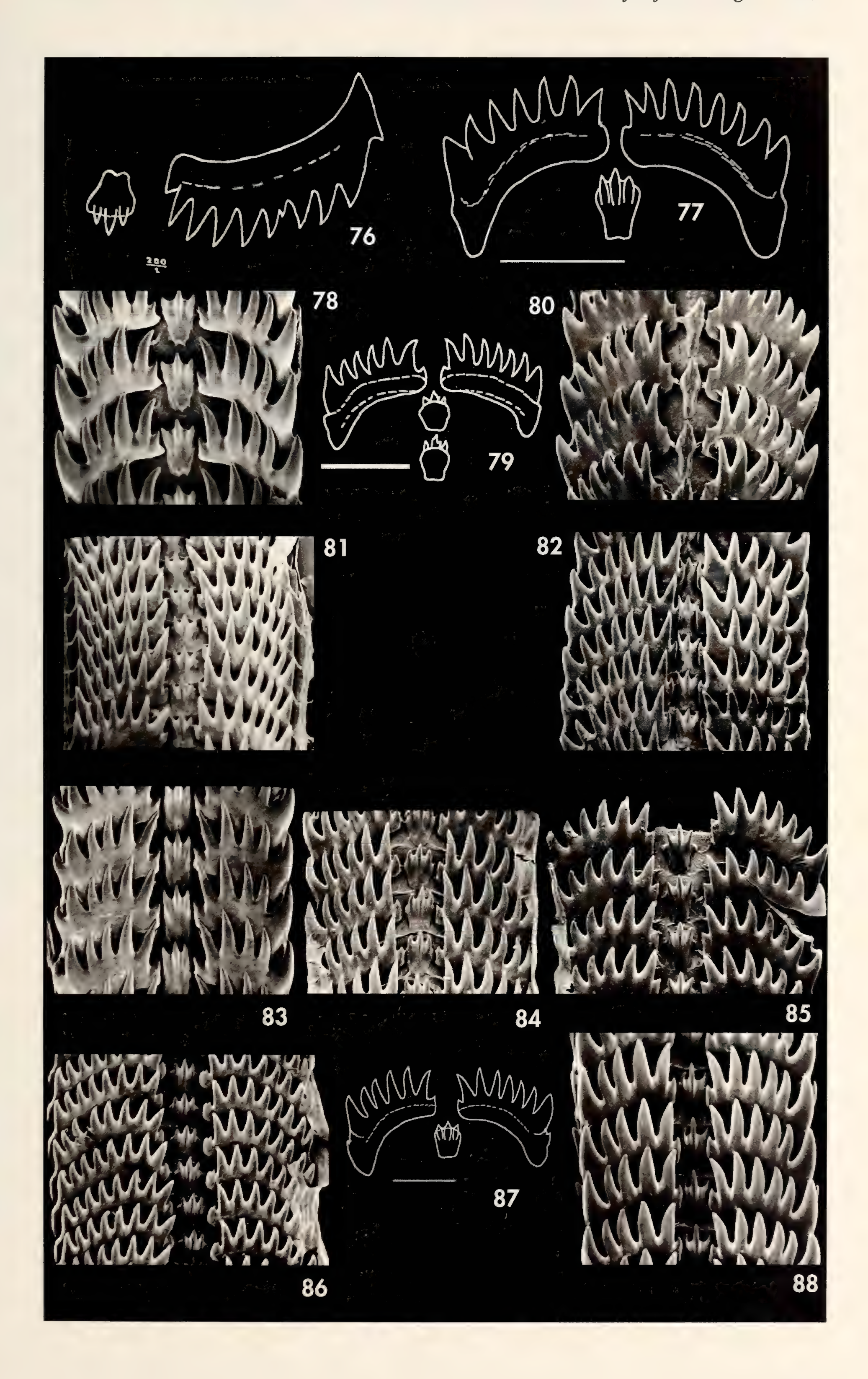
Nine to twelve rather weak, narrow axial ribs on 4 uppermost teleoconch whorls, reaching from suture to suture on first postnuclear whorl. Withdrawing from upper suture on second whorl. On third or fourth whorl ribs suddenly weaker, gradually fading away on following whorls. Growth lines curved, fine.

About 4 or 5 rather weak spiral cords on uppermost whorl. From second postnuclear whorl on, a fine intercalated secondary spiral thread appears between each pair of primary cords. On following whorls numerous fine and inconspicuous tertiary spiral threads appear. Lower whorls covered by conspicuously fine spiral sculpture, axial sculpture obsolete.

Aperture large, oval, pointed above, white. Parietal callus smooth and thin. Outer lip thin, simple, without internal lirae. Columellar folds absent. Siphonal canal shorter than aperture, rather broad, strongly curved and widely opened.

(Right page) Figures 76-88. Radulae. 76: *Fusinus (Chryseofusus) chrysodomoides* (Schepman, 1911), reproduced from SCHEPMAN (1911: fig. 10). 77: *Fusinus (Chryseofusus) subangulatus* (von Martens, 1901); 78: *Fusinus (Chryseofusus) bradneri* (Drivas and Jay, 1990), juvenile specimen; 79: *Fusinus (Chryseofusus) kazdailisi* Fraussen and Hadorn, 2000; 80: *Fusinus (Chryseofusus) acherusius* sp. nov.; 81: *Fusinus (Chryseofusus) jurgeni* Hadorn and Fraussen, 2002; 82: *Fusinus (Chryseofusus) artutus* sp. nov.; 83: *Fusinus (Chryseofusus) riscus* sp. nov.; 84: *Fusinus (Chryseofusus) cadus* sp. nov.; 85: *Fusinus (Chryseofusus) alisae* sp. nov.; 86: *Fusinus (Chryseofusus) chrysodomoides* (Schepman, 1911); 87: *Fusinus (Chryseofusus) graciliformis* (Sowerby, 1880), Holotype *Fusinus valdiviae* Hadorn and Fraussen, 1999 (junior synonym); 88: *Fusinus (Chryseofusus) scissus* sp. nov.

(Página derecha) Figuras 76-88. Rádulas. 76: Fusinus (Chryseofusus) chrysodomoides *(Schepman, 1911), reproducido de SCHEPMAN (1911: fig. 10); 77:* Fusinus (Chryseofusus) subangulatus *(von Martens, 1901); 78:* Fusinus (Chryseofusus) bradneri *(Drivas y Jay, 1990), juvenil; 79:* Fusinus (Chryseofusus) kazdailisi *Fraussen y Hadorn, 2000; 80:* Fusinus (Chryseofusus) acherusius *sp. nov.; 81:* Fusinus (Chryseofusus) jurgeni *Hadorn y Fraussen, 2002; 82:* Fusinus (Chryseofusus) artutus *sp. nov.; 83:* Fusinus (Chryseofusus) riscus *sp. nov.; 84:* Fusinus (Chryseofusus) cadus *sp. nov.; 85:* Fusinus (Chryseofusus) alisae *sp. nov.; 86:* Fusinus (Chryseofusus) chrysodomoides *(Schepman, 1911); 87:* Fusinus (Chryseofusus) graciliformis *(Sowerby, 1880), Holotipo* Fusinus valdiviae *Hadorn y Fraussen, 1999 (sinónimo junior); 88:* Fusinus (Chryseofusus) scissus *sp. nov.*



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Operculum typical of genus, corneous, brown, ovate, pointed at lower end, shape and size corresponding to aperture, with terminal nucleus. Outer side ornamented with numerous concentric growth lines.

Periostracum and radula unknown.

Range and habitat: Only known from western Australia. WILSON (1994) reported this species as *Siphonofusus chrysodomoides* (Schepman, 1911) from off Rowley Shoals to Rottnest Island between 300-500 m deep.

Comparison: *F. westralis* has hitherto been identified and offered to collectors as "*Siphonofusus chrysodomoides*". Authors figured this species as *S. chrysodomoides* (KOSUGE, 1985; WILSON, 1994) and as *Fusinus chrysodomoides* (HADORN AND FRAUSSEN, 1999). Wilson noted the generic allocation of this species provisional. Hadorn and Fraussen placed this species in *Fusinus* based on conchological resemblance with *F. valdiviae*. After studying the Indonesian type material of *Fusus chrysodomoides* we describe the western Australian shells as *F. westralis*.

F. westralis differs from *F. chrysodomoides* by the larger shell size, the more slender and more extended spire tip, the larger number of whorls, the more concave shoulder slope especially on the lower whorls, the narrower interspaces between axial ribs on upper whorls, and finally by the much finer spiral sculpture and the much larger number of very fine intercalated spiral threads.

BIOGEOGRAPHICAL DISCUSSION

The distribution of the 16 species of *Chryseofusus* probably partly reflects actual distribution patterns and sampling efforts. One species is known from the East Pacific (*kazdailisi*) and Western Australia (*westralis*), and these two species are not known from elsewhere. Five species are known from East and Southeast Asia (*chrysodomoides*, *graciliformis*, *hyphalus*, *artutus* and *dapsilis*), of which two (*hyphalus*, *dapsilis*) are not known from elsewhere. Six species are known from East Africa and the southwest Indian Ocean (*chrysodomoides*, *graciliformis*, *subangulatus*, *bradneri*, *acherusius* and *jurgeni*), of which three (*subangulatus*, *bradneri* and *jurgeni*) are not known from elsewhere. Finally, eight species are known from the SW Pacific (*chrysodomoides*, *acherusius*, *artutus*, *riscus*, *cadus*, *alisae*, *scissus* and *wareni*), of which five (*riscus*, *cadus*, *alisae*, *scissus*, *wareni*) are not known from elsewhere.

The highest diversity is encountered in New Caledonia, where all eight species known in the southwest Pacific co-occur, of which four (*riscus*, *cadus*, *alisae* and *scissus*) can be regarded as local. In the North of New Caledonia, up to three species (*cadus*, *alisae*, *wareni*) potentially occupy the same bathymetric horizon between 300 and 545 m (whereas *chrysodomoides* occupies slightly deeper water), but none of them occurs syntopically with another species. In the South and on Norfolk Ridge, up to four species (*chrysodomoides*, *cadus*, *riscus*, *scissus*) potentially occupy the same bathymetric horizon between 401 and 675 m, and there is a single occurrence where two species have been taken together in the same haul (SMIB 1 stn DW2: *chrysodomoides*, *scissus*). The high diversity in the New Caledonia region thus apparently reflects high environmental heterogenity as well as individual specific ecological preferences (Table I). The data for the southwest Indian Ocean are more scanty but tend to support the same conclusion: up to four (*chrysodomoides*, *graciliformis*, *bradneri* and *jurgeni*) occupy the same bathymetric horizon between 350 and 600 m in the Mozambique Channel, but we have no documented case of syntopy.

ACKNOWLEDGMENTS

P. Bouchet (MNHN), B. Richer de Forges (IRD, Nouméa) and A. Warén (SMNH) collectively collected most of the material on which this paper is based. V. Héros (MNHN) arranged for the loan of

Table I. Geographical and bathymetrical distribution of species of *Chryseofusus* in the New Caledonia region.
Tabla 1. Distribución geográfica y batimétrica de las especies de Chryseofusus *en la región de Nueva Caledonia.*

Species	Coral Sea	North New Caledonia	New Caledonia proper	Norfolk Ridge	Loyality Ridge
chrysodomoides		610-705		415	577-600
acherusius				1850-1900	
artutus			435		
cadus		525		460-675	
alisae	355-400	300-545			
riscus				401-430	
scissus				410-580	
wareni		480-490			751-755

additional MNHN material, A. Warén prepared radulae and SEM illustrations, and P. Bouchet revised an earlier draft of the manuscript. We thank R. Moolenbeek (ZMA), J. Goud (RMNH), E. Gittenberger (RMNH), K. Way (BMNH), J. Pickering (BMNH), R. Kilburn (NM), H. Saito (NSMT), M. Gosteli (NMBE) and M. Glaubrecht (ZMB) for the loan of type material, S. Kosuge (IMT) for Japanese literature and translation, R. Houart (Belgium) for comments, corrections and important help to the manuscript, B. Briano (Italy), B. Rogers (USA), C. Takahashi (USA), R. Kelly (USA), H. Danila (Lithuania), K. de Turck (Belgium), L. Bozzetti (Italy), M.A. Snyder (USA), D. Howlett (England) and G. Poppe (Belgium) for providing useful information and/or material for comparison, V. Wiese (Haus der Natur, Germany) and M.A. Snyder (USA) for reviewing the manuscript, and finally D. Monsecour (Belgium) for correcting the English text.

BIBLIOGRAPHY

BIELER, R. AND PETIT, R. E., 1990. On the various editions of Tetsuaki Kira' s "Coloured Illustrations of the Shells of Japan" and "Shells of the Western Pacific in Color, Vol. I", with an annotated list of new names introduced. *Malacologia*, 32: 131-145.

BIELER, R. AND PETIT, R. E., 1996. Additional notes on nomina first introduced by Tetsuaki Kira in "Coloured Illustrations of the shells of Japan". *Malacologia*, 38 (1-2): 33-34.

BOUCHET, P. AND WARÉN, A., 1986. Taxonomical notes on tropical deep water Buccinidae with descriptions of new taxa. Résultats des Campagnes Musorstom, volume 4. *Mémoires du Muséum National d'Histoire Naturelle*, ser. A, 133: 457-517.

BRUGUIÈRE, J. G., 1789. *Encyclopédie méthodique. Histoire naturelle des vers.* Vol. 1, part 1. Panckoucke, Paris, 344 pp.

CROSNIER, A., RICHER DE FORGES, B. AND BOUCHET, P., 1997. La campagne KARUBAR en Indonésie, au large des iles Kai et Tanimbar. In Crosnier, A. and Bouchet, P. (eds), Résultats des Campagnes Musorstom, volume 16. *Mémoires du Muséum national d'Histoire Naturelle*, 172: 9-26.

DRIVAS, J. AND JAY, M., 1998. The Fasciolariidae of Réunion. *La Conchiglia*, 289 suppl.: 35-39.

FRAUSSEN, K., 1999. A listing of Recent *Euthria* (Mollusca: Gastropoda: Buccinidae). *Gloria Maris*, 37 (5-6): 77-81.

FUJITA, T., 1929. Report on the dredged shells of Tateyama Bay (2). *Venus*, 1 (3): 88-97, pl. III.

HADORN, R. AND FRAUSSEN, K., 1999. Rediscovery of *Fusinus subangulatus* (von Martens, 1903) and description of a new Somalian *Fusinus* (Gastropoda: Fasciolariidae), including some notes on the taxonomical position of the genus *Siphonofusus* Kuroda and Habe, 1952. *Vita Marina*, 46 (3-4): 111-122.

HIGO, S., CALLOMON, P., AND GOTO, Y., 1999. *Catalogue and bibliography of the marine shell-bearing Mollusca of Japan*. Elle Scientific Publications, Japan, 749 pp.

KIRA, T., 1962. *Shells of the Western Pacific in Color (I)*. Hoikusha Publishing CO., Ltd., Osaka, Japan, 224 pp. [for additional printings, see BIELER AND PETIT, 1990].

KOSUGE, S., 1985. Noteworthy Mollusca from North-western Australia (1) (Preliminary report). *Bulletin of the Institute of Malacology-Tokyo*, 2 (3): 58-59.

KURODA, T. AND HABE, T., 1971 *in* Kuroda, Habe and Oyama. [Descriptions of genera and species], *The sea shells of Sagami Bay*. Maruzen, Tokyo. xix + 741 pp. [in Japanese], pls. 1-121, 489 pp. [in English], 51 pp. index, map.

MALLARD, D., 2001. Survey into Fasciolariidae. *Xenophora*, 95: 8-15.

MARTENS, E. VON, 1904. Die beschalten Gastropoden der deutschen Tiefsee-Expedition 1898-1899. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898-1899*, 7 (1), part A: 1-180, pl. 1-9. Jena.

RICHER DE FORGES, B., 1990. Les campagnes d' exploration de la faune bathyale dans la zone économique de la Nouvelle-Calédonie. Explorations for bathyal fauna in the New Caledonian economic zone. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 6. *Mémoires du Muséum national d'Histoire naturelle, (A)*, 145: 9-54.

RICHER DE FORGES, B., 1993a. La campagne MUSORSTOM 7 dans la zone économique des iles Wallis et Futuna. Compte rendu et liste des stations. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 10. *Mémoires du Muséum national d'Histoire naturelle*, 156: 9-25.

RICHER DE FORGES, B., 1993b. Campagnes d' exploration de la faune bathyale faites depuis mai 1989 dans la zone économique de la Nouvelle-Calédonie. Liste des stations. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 10. *Mémoires du Muséum national d'Histoire naturelle*, 156: 27-32.

RICHER DE FORGES, B. AND CHEVILLON, C., 1996. Les campagnes d' échantillonage du benthos bathyal en Nouvelle-Calédonie, en 1993 et 1994 (BATHUS 1 à 4, SMIB 8 et HALIPRO 1). In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 15. *Mémoires du Muséum national d'Histoire naturelle*, 168: 33-53.

RICHER DE FORGES, B., FALIEX, E. AND MENOU, J. L., 1996. La campagne MUSORSTOM 8 dans l' archipel de Vanuatu. Compte rendu et liste des stations. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 15. *Mémoires du Muséum national d'Histoire naturelle*, 168: 9-32.

RICHER DE FORGES, B., NEWELL, P., SCLACHER-HOENLINGER, M., SCHLACHTER, T., NATING, D., CÉSA, F. AND BOUCHET, P., 2000. La campagne MUSORSTOM 10 dans l' archipel des iles Fidji. Compte rendu et liste des stations. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 21. *Mémoires du Muséum national d'Histoire naturelle*, 184: 9-23.

RICHER DE FORGES, B., BOUCHET, P., DAYRAT, B., WARÉN, A. AND PHILIPPE, J. S., 2000. La campagne BORDAU 1 sur la ride de Lau (iles Fidji). Compte rendu et liste des stations. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 21. *Mémoires du Muséum national d'Histoire naturelle*, 184: 25-38.

ROUX, M., 1994. The CALSUB cruise on the bathyal slopes off New Caledonia. In Crosnier, A. (ed.), Résultats des Campagnes Musorstom, volume 12. *Mémoires du Muséum national d'Histoire naturelle*, 161: 9-47.

SCHEPMAN, M. M., 1911. The Prosobranchia of the Siboga Expedition. Rachiglossa. *Résultats Siboga Expeditie*; Mon 49 (1), part 4: 1-452, pls. 1-30. Leiden.

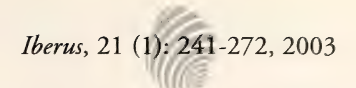
SNYDER, M. A., 2000. Nomenclatural emendations in the family Fasciolariidae (Mollusca: Gastropoda). *Proceedings of the Academy of Natural Sciences of Philadelphia*, 150: 173-179.

SPRINGSTEEN, F. J. AND LEOBRERA, F. M., 1986. *Shells of the Philippines*. Carfel Seashell Museum, Manila, 377 pp.

VERDUIN, A., 1977. On a remarkable dimorphism of the apices in many groups of sympatric, closely related marine gastropods species. *Basteria*, 41: 91-95.

WILSON, B. R., 1994. *Australian marine Shells, 2*. Odyssey Publ., Kallaroo, Western Australia, 370 pp.

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The Cystiscidae (Caenogastropoda) from upper reef formations of New Caledonia

Los Cystiscidae (Caenogastropoda) de las formaciones superiores de coral de Nueva Caledonia

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Recibido el 16-I-2003. Aceptado el 14-III-2003

ABSTRACT

The species of Cystiscidae from the New Caledonian upper reef formations are studied on the ground of recent intensive recolts managed by Paris Museum, mainly the ones from Noumea 1992-93, from the Expedition Montrouzier 1993 and from the Expedition Lifou 2000. The taxonomic analysis is focused on the morphs sampled off New Caledonia mainland (northern and southern areas). The marginellids collection of Bavay recently deposited in Paris Museum is used for the revision of several taxa.

Twenty eight morphs are recognized, among which five are attributed to species previously described, namely *Gibberula lifouana* (Crosse, 1871), *Cystiscus goubini* (Bavay, 1922), *C. montrouzieri* (Bavay, 1922), *C. bougei* (Bavay, 1917) and *Plesiocystiscus tomlini* (Bavay, 1917), the last one with much reserve. The syntypes of *Gibberula pulchella* (Kiener, 1834) are pictured and the species is compared to a New Caledonian relative.

Eighteen species are described as new: *Gibberula squamosa* sp. nov., *G. cincta* sp. nov., *Crithe caledonica* sp. nov., *C. gofasi* sp. nov., *Cystiscus viridis* sp. nov., *C. punctatus* sp. nov., *C. aurantius* sp. nov., *C. marshalli* sp. nov., *C. boucheti* sp. nov., *C. camelopardalis* sp. nov., *C. minor* sp. nov., *C. pardus* sp. nov., *C. deltoides* sp. nov., *C. caeruleus* sp. nov., *C. tricinctus* sp. nov., *C. pseudoaurantius* sp. nov., *C. cooverti* sp. nov., *Plesiocystiscus bavayi* sp. nov.

Five morphs are recorded as potential new species and provisionally referred as *Gibberula* sp. aff. *philippii* (Monterosato, 1878) (morphs A, B and S), *Cystiscus* sp. 1 and *Plesiocystiscus* sp. aff. *bavayi* sp. nov.

Despite the high diversity reported about the group *Crithe/Cystiscus* in shallow waters of New Caledonia mainland, this diversity is appreciated as remaining much underestimated. This diversity cannot be considered as restricted to the New Caledonian waters and equivalent intensive collecting efforts in other places from West Pacific might possibly yield equivalent results.

The genera *Crithe* and *Cystiscus* show as belonging to a continuous complex of related forms, but the taxonomic unification of the group waits for a better knowledge of its total diversity, allowing to propose appropriate subdivisions.

On the ground of the concrete limits met with the taxonomic interpretation, it is suggested that the managing of systematic observations in the field about micro-habitats and about the variability of the soft parts would highly increase the scientific profitability of intensive malacological samplings.

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RESUMEN

Las especies de Cystiscidae de la parte superior de las formaciones arrecifales de Nueva Caledonia son estudiadas en base a las recientes recolecciones intensivas dirigidas por el Museum de Paris, principalmente las de Noumea 1992-93, la Expedition Montrouzier 1993 y la Expedition Lifou 2000. El análisis taxonómico se centra principalmente en los morfos obtenidos fuera de New Caledonia (areas del norte y sur). La colección de marginélidos de Bavay, recientemente depositada en el Museum de Paris ha sido usada para la revisión de varios taxones.

Se reconocen veintiocho morfos, entre los cuales cinco son atribuidos a especies previamente descritas, como *Gibberula lifouana* (Crosse, 1871), *Cystiscus goubini* (Bavay, 1922), *C. montrouzieri* (Bavay, 1922), *C. bougei* (Bavay, 1917) y *Plesiocystiscus tomlini* (Bavay, 1917), aunque este último con muchas reservas. Los sintipos de *Gibberula pulchella* (Kiener, 1834) son mostrados y la especie es comparada con una similar de Nueva Caledonian.

Diez y ocho especes son descritas como nuevas: *Gibberula squamosa* sp. nov., *G. cincta* sp. nov., *Crithe caledonica* sp. nov., *C. gofasi* sp. nov., *Cystiscus viridis* sp. nov., *C. punctatus* sp. nov., *C. aurantius* sp. nov., *C. marshalli* sp. nov., *C. boucheti* sp. nov., *C. camelopardalis* sp. nov., *C. minor* sp. nov., *C. pardus* sp. nov., *C. deltoides* sp. nov., *C. caeruleus* sp. nov., *C. tricinctus* sp. nov., *C. pseudoaurantius* sp. nov., *C. cooverti* sp. nov., *Plesiocystiscus bavayi* sp. nov.

Cinco morfos son presentados como potenciales especies nuevas y provisionalmente descritos como *Gibberula* sp. aff. *philippii* (Monterosato, 1878) (morphs A, B y S), *Cystiscus* sp. 1 y *Plesiocystiscus* sp. aff. *bavayi* sp. nov.

A pesar de la alta diversidad citada para el grupo *Crithe/Cystiscus* principalmente en aguas superficiales de Nueva Caledonia, probablemente esta diversidad esté todavía infravalorada. Sin embargo, esta diversidad no puede ser considerada restringida a las aguas de Nueva Caledonia ya que una recolección intensiva equivalente en otras zonas del Pacífico occidental posiblemente podría dar similares resultados.

Los géneros *Crithe* y *Cystiscus* muestran como vienen a ser un complejo continuo de formas relacionadas entre sí, pero la unificación taxonómica del grupo queda pendiente de un mayor conocimiento de su completa diversidad, permitiendo así proponer adecuadas subdivisiones.

Basándonos en los límites encontrados con las interpretaciones taxonómicas, se sugiere que la realización sistemáticas de las observaciones de campo acerca de los micro-hábitats y de la variabilidad de las partes blandas aumentaría el provecho científico de los muestreos intensivos.

KEY WORDS: Cystiscidae, *Gibberula, Crithe, Cystiscus, Plesiocystiscus*, New Caledonia, reef formations, sublittoral zone, diversity, soft parts chromatism.

PALABRAS CLAVE: Cystiscidae, *Gibberula, Crithe, Cystiscus, Plesiocystiscus*, Nueva Caledonia, formaciones arrecifales, zona sublitoral, diversidad, cromatismo de partes blandas.

INTRODUCTION

The malacologic prospecting of New Caledonia began around 1850 with the recolts made by the R. P. Montrouzier and was developed through the contribution of cultured local collectors, often in link with experimented European students. In these conditions, the malacological fauna from New Caledonia had become at the beginning of the XXth century one of the best known, as far as tropical latitudes are concerned.

After a period of lower activity begun around 1910, this malacologic prospecting was revived at a high level since the seventies, first about landsnails and littoral marine mollusks, soon about deep bathyal levels, leading to the discovery of a highly diversified fauna.

The boosting of this malacologic prospecting of New Caledonia is mainly due to the sustained initiatives of Paris Museum (MNHN), and of the local branch of IRD (ex-ORSTOM). Besides the managing of regular campaigns of sampling at bathyal levels, the organization of two expeditions devoted to the fauna from upper reef formations yielded intensive recolts from Northern New Caledonia (Expedition Montrouzier 1993 to Touho, NE of New Caledonia, and Koumac, NW of New Caledonia) and from Lifou Island (Expedition Lifou 2000). These important recolts, complementary to that ones made earlier around Noumea, are stored now in Paris Museum and allow the revision of the New Caledonian sublittoral mollusks on the ground of a representative material.

This article is devoted to the study of Cystiscidae (Caenogastropoda) from upper sublittoral levels of the New Caledonian mainland, among which the genus *Cystiscus* displays an original high diversity.

The marginelliform gastropods from New Caledonia were not subject to a revision work since the article of BAVAY (1922) devoting a first section (p. 57-65) to the "Marginelles de l'archipel calédonien" (including Loyalty Islands). BAVAY (1922) did recognize the occurrence of eight morphospecies of Cystiscidae, among which only three were attributed to species originally described from the New Caledonian archipelago.

On the ground of the bicolor banded animals of two sibling species of *Cystiscus* respectively recorded from Mascarene Islands and from Society Islands, and of the original radula observed in the first one, BOYER (in press b) suggested that several supraspecific natural groups may well be distinguished within the genus *Cystiscus*. The documentation displayed in the present article may help to future tentatives leading to a new taxonomic organization of the much diversified group *Crithe/Cystiscus*.

Due to the imprecise limits recognized between the genera *Crithe* and *Cystiscus*, and to the lack of control of the radulae which would allow to separate the *Plesiocystiscus* species on the ground of their full rachiglossan triplated radular system, the attributions proposed herein to these three genera must be considered as provisional. The systematics of the family Cystiscidae is here understood sensu COOVERT AND COOVERT (1995).

MATERIAL AND METHODS

The studied material belongs to the MNHN collections and comes principally from three sources:

The recolts made by P. Bouchet (MNHN) around Noumea (SW of New Caledonia) during the years 1992-93.

The recolts made by the Reef Biodiversity Workshop organized in Touho and Koumac from August to October 1993 (Expedition Montrouzier, NE and NW of New Caledonia).

The recolts made by a second worshop organized in Lifou Island (Expedition Lifou 2000, Loyalty, east off New Caledonia).

Noumea, Touho and Koumac are mainland sites with a coral lagoon within a barrier reef, which is lacking in Lifou. Koumac and Noumea are on the leeward side of the mainland island whereas Touho is on the windward side, with much resulting differences in terms of hydrodynamism and sediment types (P. Bouchet, pers. comm.).

The sampling was mainly based on advanced technics used by diving, like succion-pipe (air system) and brushing boulders and slabs on a basket-box. These technics were specially applied to the collect of the cryptic micro-fauna inhabiting the coral formations, which appear as sheltering the largest diversity at the upper sublittoral levels (0–40 m).

Some dredgings and trawlings have also been performed in 20-100 m.

A part of the collected material was observed in live state. Many species of Cystiscidae were drawn by P. Bouchet (Noumea) and by S. Gofas (Touho and Koumac). A selection of the Gofas sketches was presented without tentative identifications in BOUCHET (1994). Bouchet' s drawings are adapted herein by the author; Gofas' drawings are reproduced in their original state.

Except for few specimens conserved in alcohol, the material was dried station by station. Most of the stations were sorted out later by morphospecies. G. Coovert examined most of the material from Touho and Koumac, and did try a further selection, labelling provisional determinations.

The northern area of "Grande Terre" (mainland of New Caledonia) must be considered on the whole as the most documented by these campaigns, the surroundings of Noumea being not so intensively sampled, and the recolt from Lifou being not the subject of live observations and drawings. So, the present work is focusing on the data at hand from the New Caledonian mainland.

In most cases, the environment field data given for each station do not allow to infer what is the micro-habitat in which the subjects were sampled. Some environment labels express a somewhat homogeneous habitat and can be used as such; that is the case for instance in definitions such as: "fine sand", "detritic sand", "sandy silt on rocky floor", "brushing of boulders". But in the main cases, the environment labels mention ambiguous habitat situations (such as "outer slope", "slopes with silt", "vertical slopes and overhang", "succion-pipe on hard bottoms", in which the sampling may concern coral alveolus as well as detritic or sandy pockets) or heterogeneous habitat compositions (such as "hard bottoms, grass", "boulders, sand, grass", "sand, detritic domes", "succion-pipe on rocks, sargasses collect"). In these ambiguous or heterogeneous situations, the habitat of the subject at hand is considered as "non-recorded".

In the course of this work, several types of Bavay, considered as lost (ROTH and COAN, 1973), were found by the author within the Desjardins collection, deposited in Paris Museum on September 1999 and containing the whole Bavay' s marginellid collection (purchased by M. Desjardins to Géret' s widow during the thirties). The rediscovery of these types does allow to reassess some cystiscid species whose status remained uncertain.

Abbreviations:

NC: New Caledonia
AMS: Australian Museum, Sydney
IRD: Institut de Recherche pour le Développement, Paris (ex-ORSTOM)
IRSNB: Institut Royal des Sciences Naturelles de Belgique, Bruxelles
MNHG: Muséum national d'Histoire naturelle de Genève
MNHN: Muséum national d'Histoire naturelle, Paris
NMNZ: National Museum of New Zealand
NSMT: National Science Museum, Tokyo
FBC: author' s collection
MDC: Maxime Desjardins collection
ad: adult
fr: fragment
juv: juvenile
sh: dead collected subject
spm: live collected subject
stn: station
subad: subadult

RESULTS

Family CYSTISCIDAE Stimpson, 1865
Genus *Gibberula* Swainson, 1840

Type species: *Gibberula zonata* Swainson, 1840 = *Volvaria oryza* Lamarck, 1822, by monotypy.

Gibberula squamosa sp. nov. (Figs. 5-8, 23)

Type material: Holotype (Figs. 5, 6, 23) in MNHN Touho, stn 1269. Numerous paratypes (ad/juv, spm/sh) from the type locality in MNHN; 2 ad spm in AMS; 2 ad spm in NMNZ; 2 ad spm in NSMT.
Other material studied: Noumea, 1992: stn 1339, 22° 21.9′ S, 166° 15.4′ E, 20 m, 6 ad spm, 1 juv spm; Great Reef Aboré, 22° 22.26′ S, 166° 15.92′ E, 12-37 m, 4 ad spm, 1 juv spm; stn 1355, 22° 18.9′ S, 166° 26.6′ E, 7-10 m, 1 ad sh.
Expedition Montrouzier, Touho, 1993: stn 1237, 20° 46.9′ S, 165° 13.8′ E, 0-1 m, 4 ad spm, 2 juv spm, 1 ad sh; stn 1251, 20° 46.0′-20° 46.5′ S, 165° 13′-165° 14.5′ E, 6-15 m, 1 ad sh; stn 1270, 20° 45′ S, 165° 16.5′ E, 10-35 m, numerous spm and sh; stn 1272, 20° 49.5′ S, 165° 19.6′ E, 10 m, numerous spm; stn 1273, 20° 50.4′ S, 165° 22.8′ E, 20 m, numerous spm and sh.
Expedition Montrouzier, Koumac, 1993: stn 1312, 20° 40.4′ S, 164° 14.9′ E, 26-40 m, 1 ad spm; stn 1319, 20° 44.7′ S, 164° 15.5′ E, 15-20 m, 1 juv sh; stn 1323, 20° 40.9′ S, 164° 14.8′ E, 82-120 m, 1 juv sh.
Expedition Lifou 2000: stn 1435, 20° 55.2′ S, 167° 00.7′ E, 5-30 m, 8 ad sh (Figs. 7, 8), 3 juv sh.
Type locality: Touho area, Doiman Reef, stn 1269, 20° 35.1′ S, 165° 08.1′ E, 15-20 m, outer slope.
Etymology: From the scale aspect presented by the shell decoration of rounded and connected axial convolutions.

Shell description (Figs. 5, 6): Short, solid, rounded oval. Spire flat, faintly umbilicate, aperture narrow, moderate siphonal notch, four distinct columellar plaits and a faintly distinct fifth upper one. Lip not distinctly denticulate, fine spiral lirations on the inner wall of the outer lip. Outer lip angular, not marginate.

Axial decoration of very sinuous brown lines on a creamy ground, making six blunted convolutions oriented towards the left. Axial lines thickened at the level of the central intervals, suggesting a darker central spiral zone. Less distinct dark spiral zones occur at the upper and lower level of the axial convolutions, which are merging into whitish zones at both tips.

Size: 4.25 x 2.80 mm.

Animal description (Fig. 23): Bifurcated head, long tentacles and siphon, foot large and flat. Head, siphon and foot decorated with large yellowish patches and small orange stains. The centre of the head lobes and the central part of the metapodium are greenish. Eyes black. The inner mantle shows alternate zones of yellow, orange and greenish colour.

Distribution: Known from the whole NC archipelago, alive from the intertidal to 26, empty shells to 82 m. Abundant in Touho, uncommon in Noumea and Koumac, rare in Lifou.

Habitat: Collected on hard bottoms with patchy sediments or sandy film, in silt with dead shells, in fine sands with grass.

Remarks: *G. squamosa* sp. nov. shows close similarities with *G. pulchella* (Kiener, 1834) from Australia, which has however a larger, more slender and oblong shell, bearing a decoration of more numerous and sharper axial convolutions. The two syntypes of *G. pulchella* pictured herein (Figs. 1-4) measure respectively 7.9 x 4.5 mm and 7.4 x 4.1 mm (MHNG n° 1152/64), whereas *G. squamosa* does not exceed 5 mm in length. *G. pulchella* seems to be sympatric in its type locality of Sydney with at least one other zigzag ornated species (FBC) of smaller size which looks as closely related to *G. squamosa* and ranges up to South West Australia (FBC). The complex of zigzag ornated *Gibberula* presenting with evidence a great number of species only distinguishable on the basis of subtile differences (BOYER, in press a), we provisionally reserve the name *G. squamosa* to the populations represented in NC, characterized by short shells with a limited number of convolutions, and propose to report the similar Indo-Pacific populations as *G.* cf. *squamosa*. Shells looking as very similar to the types of *G. pulchella* are found in Norfolk Island (FBC).

Gibberula lifouana (Crosse, 1871) (Figs. 9-12)

Marginella lifouana Crosse, 1871, p. 205-206. Type figures in Crosse, 1872, pl. II, fig. 2.

Type material: 1 syntype (Fig. 9) in MNHN, here selected as lectotype Label: "*Marginella lifouana* Crosse I. Lifou (Loyalty) M. Marie par M.E. Marie typus".
Other material studied: Expedition Montrouzier, Touho, 1993: stn 1242, 20° 46.2′ S, 165° 14.5′ E, tide, 1 ad spm (Fig. 12), 7 juv spm.
Expedition Lifou 2000: stn 1419, 20° 55.6′ S, 167° 04.5′ E, 5 m, numerous spm and sh; stn 1422, 20° 47.1′ S, 167° 07.4′ E, 4 m, numerous spm and sh; stn 1424, 20° 54.9′ S, 167° 03.0′ E, 4m, numerous spm and sh (Figs. 10, 11); stn 1425, 20° 46.8′ S, 167° 07.2′ E, 4-5 m, numerous spm and sh; stn 1453, 20° 54.6′ S, 167° 02.1′ E, 21-30 m, 1 ad spm, 4 ad and juv sh.
Type locality: Lifou Island, Loyalty.

Shell description (Fig. 9): Short, subpyriform. Spire flat, protoconch produced, aperture moderately narrowed, widening to the base, deep siphonal notch, four distinct columellar plaits and faint upper lirations running along the apertural wall. Outer lip smooth, flexuous, angular, not marginate. Axial decoration of sharp angular zig-zag mustard yellow lines on a white ground.

Size: 4.5 x 2.8 mm.

Animal: Unknown.

Distribution: *G. lifouana* is abundant in upper sublittoral levels from Lifou Island. The species seems to be very scarce off NC mainland (one present record from Touho). Alive in 0-21 m, empty shells in 4-21 m.

Habitat: *G. lifouana* seems to be restricted to soft bottoms, but it is recorded from rough sands as well as fine silty sediments.

Remarks: *G. lifouana* shows a more pyriform shell than the one of *G.squamosa*, with a slightly wider aperture, a deeper siphonal notch, and a small teat-like pointed protoconch, not visible in *G.squamosa*. Both species are principally separable on the ground of their shell decoration, as *G. lifouana* has very angular pointed axial zigzag lines, whereas *G. squamosa* has rounded and blunted convolutions. Any kind of intergrades does not exist, despite the fact that both species have been found sympatrically.

Gibberula cincta sp. nov. (Figs. 13-16)

Type material: Holotype (Figs. 13, 14) in MNHN, Noumea, stn 1347. Paratypes: 20 ad spm (Figs. 15, 16) + sh and 8 juv spm + sh, in MNHN; 2 ad sh in AMS; 2 ad sh in NMNZ; 2 ad sh in NSMT.
Other material studied: Noumea, 1993: stn 1367, 22° 24.3′ S, 166° 20.7′ E, 10 m, 1 ad sh, 3 juv sh; stn 1368, 22° 24.3′ S, 166° 20.7′ E, 10 m, 3 ad spm, 1 ad sh, 1 juv sh.
Type locality: Noumea area, Great Reef Aboré, stn 1347, 22° 23.6′ S, 166° 20.1′ E, 10 m, silty sand on rock floor.
Etymology: From the spiral ranks of dots ornating the shell.

Shell description (Figs. 13, 14): Short, solid, subpyriform. Spire almost absent, small teat-like apex, aperture narrow, deep siphonal notch, four distinct columellar plaits and a faintly distinct fifth upper one. Lip not distinctly denticulate, no visible spiral lirations on the inner wall of the outer lip. Outer lip angular, not marginate. Spiral decoration of six ranks of small regularly spaced out yellowish brown dots. A brown continuous line underlines the suture and reachs the protoconch.

Size: 4.2 x 2.9 mm.

Animal: Unknown.

Distribution: Known only from the Noumea area, SW coast of NC. Alive and empty shells in 10 m.

Habitat: Apparently restricted to soft bottoms, in white sands and silty sand.

Remarks: *G. cincta* sp. nov appears as closely allied to *G. lifouana*. The "dotted phase" is also known as occurring as an intraspecific variation in some zigzag ornated species of *Gibberula*. That is for instance the common phase in *Gibberula deburghi* (A. Adams, 1864) from South West Australia, whereas zigzag ornated and intergrading subjects may occur in this species, specially in the northern part of the species distribution (pers. obs.).

The shell outline of *G. cincta* is squatter and more rounded than in *G. lifouana*, with a less flexuous labrum. The number of dots on each spiral rank in *G. cincta* is higher than the number of left (or right) oriented convolutions tips in *G. squamosa*, and the brown subsutural line doesnot exist in this species. No kind of intergrading form is observed in sympatric material.

G. cincta must be accepted as a species belonging to the zigzag ornated *Gibberula* complex. In the case of *G. cincta*, the tips of convolutions thickness are conserved as perfect points, whereas other species may have conserved homologous marks as "arrow-pointed accents" [that is the case for instance in *Gibberula thomensis* (Tomlin, 1918) from the oceanic islands situated off the coasts of Gabon].

Gibberula sp. aff. *philippii* (Figs. 17-22, 24-26)

Sorting out the small white-shelled *Gibberula* from Touho and Koumac, G. Coovert separated three morphospecies corresponding to the drawings of live animals made in Touho by S. Gofas:

Morph A corresponds to the shell pictured in Figures 17 and 18, whose own animal is pictured in fig. 24 (NC 309). Two similar pictures (NC 136 and NC 310) were performed.

Morph B corresponds to the shell pictured in Figures 19 and 20, whose own animal is pictured in Figure 25 (NC 360).

Morph S corresponds to the shell pictured in Figures 21 and 22, whose own animal is pictured in Figure 26 (NC 614).

G. Coovert separated as such many lots of shells from Koumac, and some few from Touho. A re-assessment of this arrangement led to distinguish several homogeneous morphs in some stations, but also to find many intergrades linking these morphs in other places (for shell size as well as shell morphology). A fourth morph from Koumac separated by G. Coovert as morph R, presenting a medium-sized ogival shell, also looks as a possible intergrade between the morphs A, B and S.

Even if several species are possibly occurring here, the informations given by the field sketches of live animals are not sufficient in the present state to define specific unities. All these morphs belong to the "*G. philippii* group" [from the mediterranean *G. philippii* (Monterosato, 1878)], whose species currently show a high variability of the soft parts. For instance morph A, as represented in figures 17 and 18, and in figure 24, perfectly matches the most common form of *G. philippii*, by its shell morphology and size as well as by the chromatism of its soft parts (see in GOFAS, 1990: 129-131, 138). The drawings NC 136 and NC 310 show the same pattern of the soft parts.

On the other hand, the chromatism of the soft parts represented in morph B (Fig. 25) is also found as a frequent variant of the *G. philippii* chromatism, and exceptional cases of melanism may occur too, looking like the sketch attributed to morph S (Fig. 26).

A resolution of the diversity pattern within the "*G. philippii* group" ranging in NC requires a deeper study of the variability of the soft parts correlated with the variability of the shell morphology, on the ground of further field observations.

Genus *Crithe* Gould, 1860

Type species: *Crithe atomaria* Gould, 1860, by monotypy.

Crithe caledonica sp. nov. (Figs. 27, 36, 45, 63, 64, 66, 67)

Type material: Holotype (Figs. 27, 36) in MNHN, Noumea, stn 1340. 5 paratypes (4 ad spm, 1 juv spm) in MNHN. 1 ad spm in AMS; 2 ad spm in NMNZ; 1 ad spm in NSMT.
Other material studied: Noumea, 1992: Great Reef Aboré, 22° 22.21′ S, 166° 16.15′ E, 15-35 m, 5 ad spm (NC 73), 1 juv spm.
Expedition Montrouzier, Touho, 1993: stn 1259, 20° 44.6′ S, 165° 13.7′ E, 15-35 m, 1 ad spm (Fig. 67); stn 1269, 20° 35.1′ S, 165° 08.1′ E, 15-20 m, 5 ad spm (Figs. 45, 64), 1 juv spm.
Expedition Montrouzier, Koumac, 1993: stn 1316, 20° 40′ S, 164° 11.2′ E, 12 m, 16 ad spm and sh (Fig. 63); stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, 2 ad spm (Fig. 66), 1ad sh, 6 juv spm; stn 1319, 20° 44.7′ S, 164° 15.5′ E, 15-20 m, 11 ad spm and sh, 7 juv spm and sh; stn 1331, 20° 40′-20° 40.6′ S, 164° 11.2′-164° 12.1′ E, 55-57 m, 7 ad sh, 1 juv sh.
Expedition Lifou 2000: stn 1429, 20° 47.5′.S, 167° 07.1′ E, 8-18 m, 7 ad sh, 4 juv sh; stn 1436, 20° 55.5′ S, 167° 04.2′ E, 47 m, 2 ad sh; stn 1449, 20° 45.8′ S, 167° 01.65′ E, 17 m, 1 ad sh; stn 1450, 20° 45.8′ S, 167° 01.65′ E, 27-31 m, 2 ad sh; stn 1451, 20° 47.3′ S, 167° 06.8′ E, 10-21 m, 2 ad sh; stn 1454, 20° 56.65′ S, 167° 02.0′ E, 15-18 m 2 ad sh.
Type locality: Noumea area, Tetembia Reef, stn 1340, 22° 21.0′ S, 166° 14.0′ E, 30 m, outer slope.
Etymology: From the widespread distribution of the species around NC mainland.

Shell description (Fig. 27): White, short, solid, inflated, rounded subpyriform. Spire excavated with a flat top, aperture widely opening to the base, three distinct anterior columellar plaits and four upper columellar varix on the parietal wall. Inner lip faintly denticulate, shoulder of the outer lip low.

Size: 1.9 x 1.3 mm.

Animal description (Fig. 36): Bifurcated head with long frontal lobes, foot small and triangular. Frontal lobes and lateral sides ahead of the red eyes are yellow, lateral sides of the head behind the eyes are reddish, borders of the central slit are orange in their frontal part and lighter behind. Eyes red. The foot is whitish, with mottled white patches on the metapodium, the inner mantle is whitish.

Distribution: Known from Noumea, Touho, Koumac and Lifou, the species does range all around the NC area. Alive from 12 to 30 m, empty shells from 8 to 55 m.

Habitat: Not accurately established. Live specimens seem to be associated to reef coral formations in the whole upper sublittoral zone..

Remarks: By its very rounded and solid shell and by the original pattern of its spire, *C. caledonica* sp. nov. shows as much distinct from all the other species belonging to the *Crithe/Cystiscus*

(Right page) Figures 1-4: *Gibberula pulchella*, syntypes, 7.9 x 4.5 mm and 7.4 x 4.1 mm, Sydney (MHNG). Figures 5-8: *G. squamosa*; 5, 6: holotype, 4.25 x 2.80 mm, Touho, stn 1269 (MNHN); 7, 8: 4.0 x 2.5 mm, Lifou, stn 1435. Figures 9-12: *G. lifouana*; 9: holotype, 4.5 x 2.8 mm, Lifou (MNHN); 10, 11: 4.2 x 2.7 mm, Lifou, stn 1424; 12: 4.2 x 2.8 mm, Touho, stn 1242. Figures 13-16: *G. cincta*; 13, 14: holotype, 4.2 x 2.9 mm, Noumea, stn 1347 (MNHN); 15, 16: paratype, 4.50 x 3.05 mm, Noumea, stn 1347 (MNHN).

(Página derecha) Figuras 1-4: Gibberula pulchella, *sintipos, 7,9 x 4,5 mm and 7,4 x 4,1 mm, Sydney (MHNG). Figuras 5-8:* G. squamosa*; 5, 6: holotipo, 4,25 x 2,80 mm, Touho, stn 1269 (MNHN); 7, 8: 4,0 x 2,5 mm, Lifou, stn 1435. Figuras 9-12:* G. lifouana*; 9: holotipo, 4,5 x 2,8 mm, Lifou (MNHN); 10, 11: 4,2 x 2,7 mm, Lifou, stn 1424; 12: 4,2 x 2,8 mm, Touho, stn 1242. Figuras 13-16:* G. cincta*; 13, 14: holotipo, 4,2 x 2,9 mm, Noumea, stn 1347 (MNHN); 15, 16: paratipo, 4,50 x 3,05 mm, Noumea, stn 1347 (MNHN).*


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complex. The shell size and morphology are very constant.

Whereas the chromatism of the head seems to be somewhat constant (Figs. 36, 63, 64, 66, 67), the ground color of the foot and the inner mantle can vary noticeably. The inner mantle ranges from dirty white to creamy yellow, light yellow and red, or light orange-red. The foot ranges from dull white to light yellowish or very light reddish.

The species seems to be abundant all around the NC mainland and in Loyalty Islands.

Crithe gofasi sp. nov. (Figs. 46, 65)

Type material: Holotype (Figs. 46, 65) in MNHN, Touho, stn 1270.
Type locality: Touho area, Great Reef Mengalia, stn 1270, 20° 45′ S, 165° 16.5′ E, 10-35 m, outer slope
Etymology: For Serge Gofas, University of Malaga (Spain), who was a pioneer of the revival of the study of marginelliform gastropods in the recent times, and who devoted to an accurate picturing of New Caledonian marginellids in the field.

Shell description (Fig. 46): White, short, solid, inflated, rounded subpyriform. Spire slightly excavated with an undulate top, outer lip much arched with a shoulder much elevated, aperture widely opening to the base, three distinct anterior columellar plaits. Inner lip smooth.

Size: 1.55 x 1.10 mm.

Animal description (Fig. 65): Bifurcated head with medium size frontal lobes, foot small and triangular.

Head hyalinous with light orange borders, except around and behind the red eyes. The borders of the central slit are darker orange. The foot is whitish translucent, mottled white on the metapodium with a reddish axis. The inner mantle is mottled light reddish and yellow.

Distribution: Only known by the holotype from Touho, NE coast of NC mainland. Alive in 10 m.

Habitat: Not recorded.

Remarks: *C. gofasi* sp. nov. can be considered as a sibling species of *C. caledonica*. The distinct features of *C. gofasi* are a smaller size, a more elevated and arched outer lip, a discoloured zone around and behind the eyes, a reddish axis on the metapodium.

As these special features were not observed in the numerous shells of *C. caledonica* and in the different specimens live pictured from Noumea, Touho and Koumac, and considering the fact that the holotype of *C. gofasi* was collected in close vicinity of *C. caledonica* specimens, a specific distinction can play validly here.

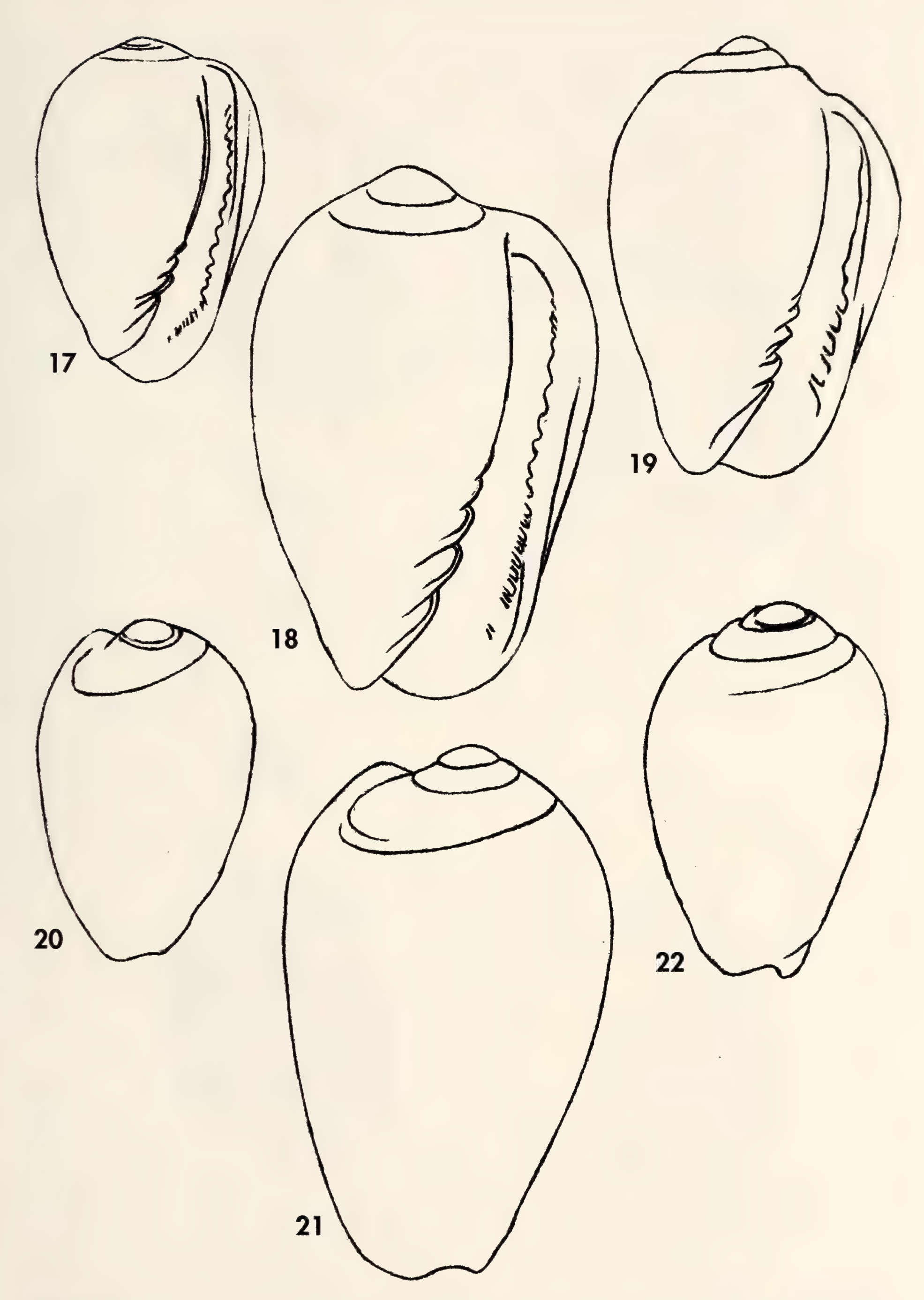
Genus *Cystiscus* Stimpson, 1865

Type species: *Cystiscus capensis* Stimpson, 1865 (non *Marginella capensis* Krauss, 1848) = *Marginella cystiscus* Redfield, 1870 (nom. nov.), by monotypy.

Cystiscus viridis sp. nov. (Figs. 28, 37)

Type material: Holotype (Figs. 28, 37) in MNHN, Noumea, stn 1340. 1 paratype (ad spm) from the type locality, in MNHN.
Type locality: Noumea area, Tetembia Reef, stn 1340, 22° 21.0′ S, 166° 14.0′, 30 m, outer slope.
Etymology: From the dominant green colour of the animal.

Shell description (Fig. 28): Translucent white, short, solid, inflated, rounded subpyriform. Spire very small, rounded protoconch slightly protuberant, aperture moderately widening to the base, three distinct anterior columellar plaits



Figures 17-22. *Gibberula* sp. aff. *philippii*. 17, 18: morph A, 1.75 x 1.20 mm, Touho, stn 1259; 19, 20: morph B, 2.90 x 1.75 mm, Touho, stn 1271; 21, 22: morph S, 2.35 x 1.50 mm, Touho, stn 1268.

Figuras 17-22. Gibberula *sp. aff.* philippii. *17, 18: morfo A, 1,75 x 1,20 mm, Touho, stn 1259; 19, 20: morfo B, 2,90 x 1,75 mm, Touho, stn 1271; 21, 22: morfo S, 2,35 x 1,50 mm, Touho, stn 1268.*

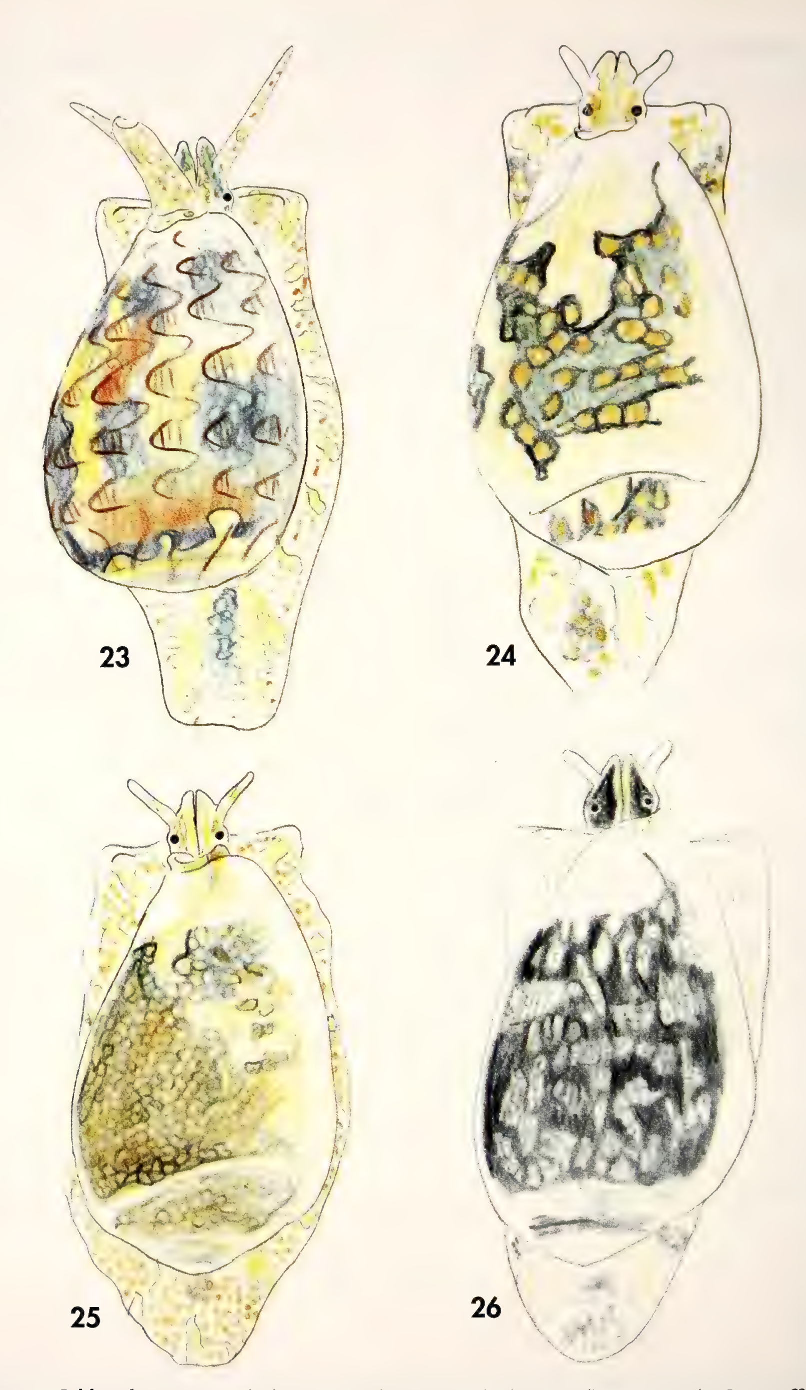


Figure 23: *Gibberula squamosa*, holotype, Touho, stn 1269 (NC 334). Figure 24: *G.* sp. aff. *philippii* morph A, Touho, stn 1259 (NC 309). Figure 25: *G.* sp. aff. *philippii* morph B, Touho, stn 1271 (NC 360). Figure 26: *G.* sp. aff. *philippii* morph S, Touho, stn 1268 (NC 614).
Figura 23: *Gibberula squamosa*, holotipo, Touho, stn 1269 (NC 334). Figura 24: *G.* sp. aff. *philippii* morfo A, Touho, stn 1259 (NC 309). Figura 25: *G.* sp. aff. *philippii* morfo B, Touho, stn 1271 (NC 360). Figura 26: *G.* sp. aff. *philippii* morfo S, Touho, stn 1268 (NC 614).

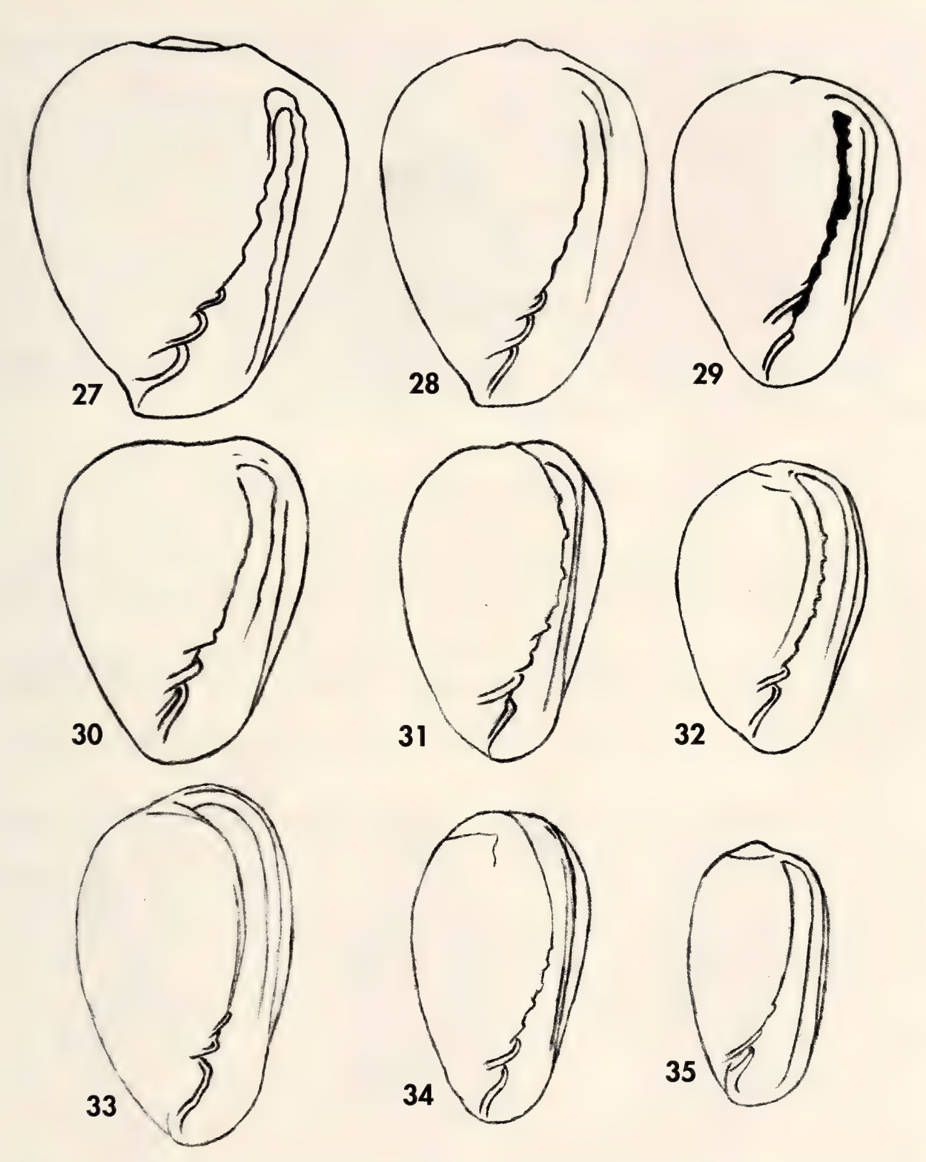


Figure 27: *Crithe caledonica*, holotype, 1.9 x 1.3 mm, Noumea, stn 1340 (MNHN). Figure 28: *Cystiscus viridis*, holotype, 1.85 x 1.10 mm, Noumea, stn 1340 (MNHN). Figure 29: *C. punctatus*, holotype, 1.5 x 1.0 mm, Noumea, stn 1336 (MNHN). Figure 30: *C. aurantius*, holotype, 1.65 x 1.15 mm, Noumea, stn 1340 (MNHN). Figure 31: *C. montrouzieri*, lectotype, 1.55 x 0.95 mm, Lifou (MNHN). Figure 32: *C. montrouzieri*, 1.45 x 0.95 mm, Noumea, stn 1360. Figure 33: *C. marshalli*, holotype, 1.8 x 1.0 mm, Noumea (MNHN). Figure 34: *C. boucheti*, holotype, 1.4 x 0.8 mm, Noumea, stn 1343 (MNHN). Figure 35: *C. camelopardalis*, holotype, 1.3 x 0.7 mm, Noumea, stn 1336 (MNHN).

Figura 27: Crithe caledonica, *holotipo, 1,9 x 1,3 mm, Noumea, stn 1340 (MNHN). Figura 28:* Cystiscus viridis, *holotipo, 1,85 x 1,10 mm, Noumea, stn 1340 (MNHN). Figura 29:* C. punctatus, *holotipo, 1,5 x 1,0 mm, Noumea, stn 1336 (MNHN). Figura 30:* C. aurantius, *holotipo, 1,65 x 1,15 mm, Noumea, stn 1340 (MNHN). Figura 31:* C. montrouzieri, *lectotipo, 1,55 x 0,95 mm, Lifou (MNHN). Figura 32:* C. montrouzieri, *1,45 x 0,95 mm, Noumea, stn 1360. Figura 33:* C. marshalli, *holotipo, 1,8 x 1,0 mm, Noumea (MNHN). Figura 34:* C. boucheti, *holotipo, 1,4 x 0,8 mm, Noumea, stn 1343 (MNHN). Figura 35:* C. camelopardalis, *holotipo, 1,3 x 0,7 mm, Noumea, stn 1336 (MNHN).*

and six upper visible low columellar varix on the parietal wall. Labrum is somewhat right in its lower part, two profile breakings in the upper part, inner border smooth, low shoulder.

Size: 1.85 x 1.10 mm.

Animal description (Fig. 37): Bifurcated head with long frontal lobes, foot small and triangular. Head and foot light green. Eyes red. Inner mantle greenish with creamy white spots, external mantle dark green.

Distribution: Only known by two specimens from the same sampling in Noumea, SW coast of NC mainland. Alive in 30 m.

Habitat: Not recorded.

Remarks: *C. viridis* sp. nov. is distinct from its relatives by its large tear-shaped shell and by the green chromatism of its animal.

C.viridis may be closely related to *Cystiscus iota* (Hedley, 1899) from Funafuti (Ellice Islands), which presents a more slender and narrowed shell, a more sinuous and somewhat elevated labrum, and a longer and sinuous first columellar plait.

Cystiscus punctatus sp. nov. (Figs. 29, 38, 73)

Type material: Holotype (Figs. 29, 38) in MNHN, Noumea, stn 1336. Paratypes: 1 subad and 2 juv spm from the type locality, in MNHN.

Other material studied: Noumea, 1992: Great Reef Aboré, 22° 22.21′ S, 166° 16.15′ E, 15-35 m, 2 ad spm.

Expedition Montrouzier, Koumac, 1993: stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, 2 juv spm (Fig. 73).

Type locality: Noumea area, Ile aux Canards, stn 1336, 22° 19.0′ S, 166° 26.1′ E, 18 m, boulders and sargasses.

Etymology: From the decoration of the inner mantle of the animal, made of black spots on an orange ground.

Shell description (Fig. 29): Translucent white, short, solid, moderately inflated, faintly subpyriform. Spire very short, slightly angular, aperture moderately widening to the base, three distinct anterior columellar plaits. Outer lip very arched in its upper part, straighter in its lower part, inner lip straight and rather smooth.

Size: 1.5 x 1.0 mm.

Animal description (Fig. 38): Bifurcated head with long frontal lobes, foot small and triangular. Head and foot deep orange. Eyes red. Inner mantle orange with black spots.

Distribution: Only known from two lots from Noumea and one lot from Koumac, both localities situated on the west coast of NC mainland. Alive from 15 to 20 m.

Habitat: Not recorded.

Remarks: *C. punctatus* sp. nov. is distinct from its relatives by its orange animal spotted with black on the inner mantle. The shell, even if smaller, shows some similarities with that ones of *C. viridis* and of *C. goubini* (Bavay, 1922) (cf. *infra*).

Cystiscus aurantius sp. nov. (Figs. 30, 39)

Type material: Holotype (Figs. 30, 39) in MNHN, 1.65 x 1.15 mm. Noumea, stn 1340. 1 paratype (ad spm) from the type locality, in MNHN.

Other materiel studied: Noumea, 1992: Great Reef Aboré, 22° 22.21′ S, 166° 16.15′ E, 15-35 m, 4 ad and 1 subad spm.

Type locality: Noumea area, Tetembia Reef, stn 1340, 22° 21.0′ S, 166° 14.0′ E, 30 m, outer slope.

Etymology: From the general orange shade of the animal.

Shell description (Fig. 30): White, short, solid, subtriangular. Spire hidden, top slightly concave, aperture moderately opening to the base, outer lip

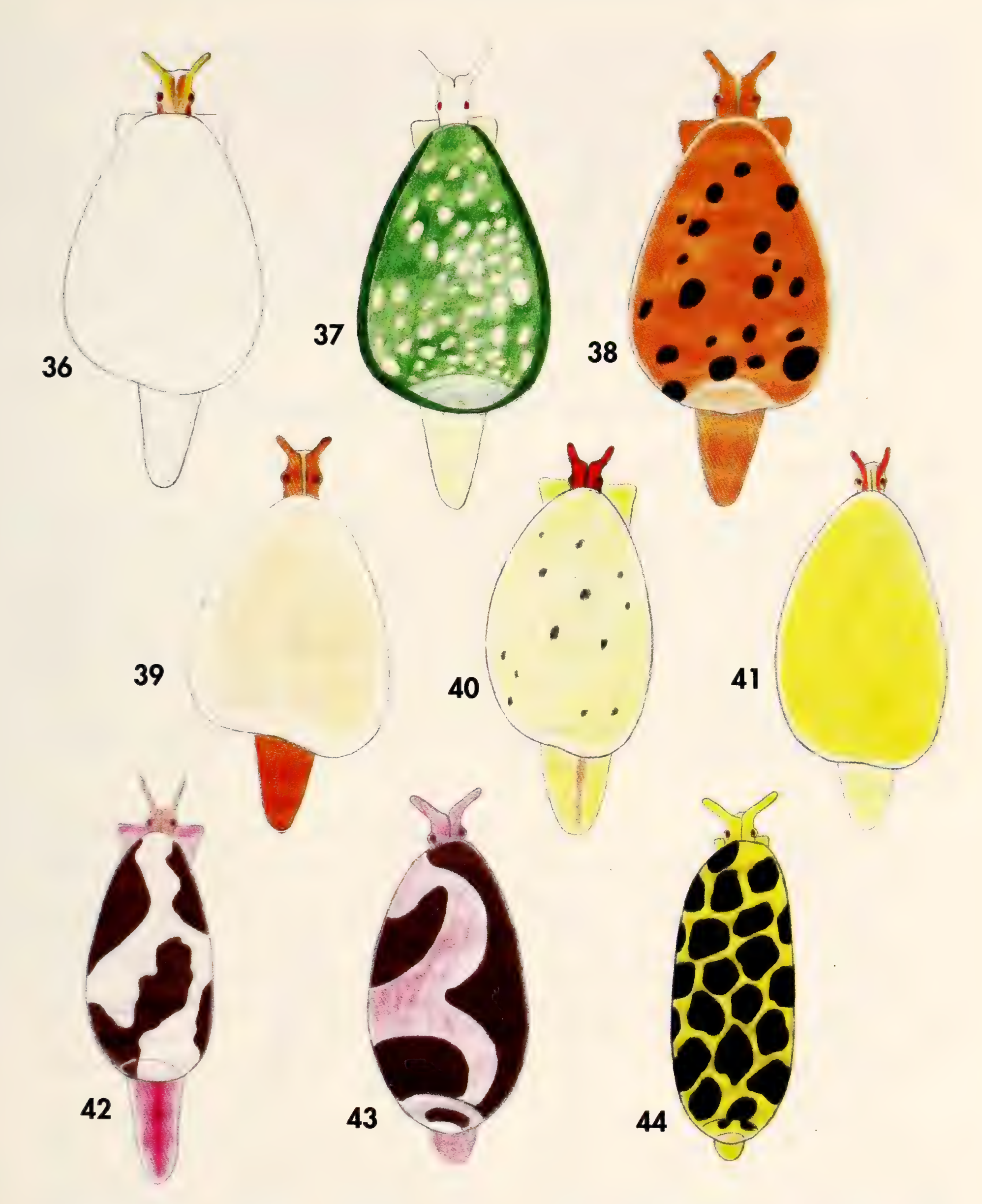


Figure 36: *Crithe caledonica*, holotype, Noumea, stn 1340 (NC 22). Figure 37: *Cystiscus viridis*, holotype, Noumea, stn 1340 (NC 23). Figure 38: *C. punctatus*, holotype, Noumea, stn 1336 (NC 12). Figure 39: *C. aurantius*, holotype, Noumea, stn 1340 (NC 24). Figure 40: *C. montrouzieri*, Noumea, stn 1360 (NC 78). Figure 41: *C. marshalli*, holotype, Noumea (NC 75). Figure 42: *C. boucheti*, holotype, Noumea, stn 1343 (NC 52). Figure 43: *C.* sp. 1, Noumea (NC 14). Figure 44: *C. camelopardalis*, holotype, Noumea, stn 1336 (NC 13).

Figura 36: Crithe caledonica, *holotipo, Noumea, stn 1340 (NC 22). Figura 37:* Cystiscus viridis, *holotipo, Noumea, stn 1340 (NC 23). Figura 38:* C. punctatus, *holotipo, Noumea, stn 1336 (NC 12). Figura 39: C. aurantius, holotipo, Noumea, stn 1340 (NC 24). Figura 40:* C. montrouzieri, *Noumea, stn 1360 (NC 78). Figura 41:* C. marshalli, *holotipo, Noumea (NC 75). Figura 42:* C. boucheti, *holotipo, Noumea, stn 1343 (NC 52). Figura 43:* C. *sp. 1, Noumea (NC 14). Figura 44:* C. camelopardalis, *holotipo, Noumea, stn 1336 (NC 13).*

arched in its upper part, with a highly produced shoulder, lower lip rather straight, inner lip almost smooth, three distinct anterior columellar plaits and one small columellar varix just above the third plait.

Animal description (Fig. 39): Bifurcated head with medium sized frontal lobes, foot small. Head and foot deep orange. Eyes red. Inner mantle creamy orange.

Distribution: Only known from two stations off Noumea, in upper sublittoral. Alive from 15 to 30 m.

Habitat: Not recorded.

Remarks: *C. aurantius* sp. nov. is distinct from *C. punctatus* by its heartshaped shell as well as the uniform creamy orange inner mantle of its animal, contrasting with the deep orange black spotted inner mantle found in *C. punctatus*.

Cystiscus montrouzieri (Bavay, 1922) (Figs. 31, 32, 40)

Marginella montrouzieri Bavay, 1922, p. 62-63, pl. I, figs. 4-5.

Type material: Lectotype (Fig. 31) and 6 paralectotypes (5 ad and 1 juv sh) in MNHN (ex-MDC). Labels: "*Ma. Montrouzieri* By I. Lifou sables", from the hand of Bavay, and "TYPE" in typed red letters. The specimen recorded as "holotype" (1.5 x 1.0 mm) by Roth and Clover (1973: 212) is a juv sh, whereas the type figures in Bavay (1922: pl. 1, figs. 4, 5) show clearly an adult subject. Furthermore, any label does not certify a status of holotype for the shell represented in "Collection du Journal", and this shell may as well belong to a different species that the one described and pictured by Bavay. So this specimen can only be considered as a syntype, and it is designated here as paralectotype n° 7, MNHN.
Other material studied: Noumea, 1993: Mberé Reef, stn 1360, 22° 19.9′ S, 166° 13.2′ E, 10-15 m, 1 ad (Figs. 32, 40) and 1 subad spm.
Type locality: Lifou.

Shell description (Fig. 31): White, short, narrow, suboval outline tapering to the base, left side much arched, right side angular in its upper part. Spire hidden, aperture high and narrow, inner lip straight, smooth, two strong anterior columellar plaits and six upper small plaits or lirations ranging all along the columellar border.

Size: 1.55 x 0.95 mm.

Animal description (Fig. 40): Bifurcated head with medium sized frontal lobes, foot small and triangular. Head reddish-orange, eyes red. Foot yellow with a reddish axis on he metapodium. Inner mantle light yellowish with small blackish stains.

Distribution: Described from Lifou. The provisional attribution to the species of the form observed in Noumea deserves to be confirmed by a control of the shell variability and overall of the animal chromatism occurring in Lifou. In Noumea, alive at 10-15 m. Bavay (1922: 63) records a "very analogous form" from Kermadec Islands. Similar forms were not observed in other places from NC mainland.

Habitat: Brushed alive on coral boulders.

Remarks: As far as the shell morphology is concerned, *C. montrouzieri* is principally comparable to *C. bougei* (Bavay, 1917) (see infra). It must be underlined that the ad spm from Noumea (Fig. 32) is noticeably different from the typical form, mainly due to the lower rupture of the outer profile of the labrum. However this feature might be representative of an intraspecific variability.

Cystiscus marshalli sp. nov. (Figs. 33, 41, 55, 76)

Type material: Holotype (Figs. 33, 41) in MNHN. Noumea, Great Reef Aboré. 1 paratype (ad spm) from the type locality, in MNHN.

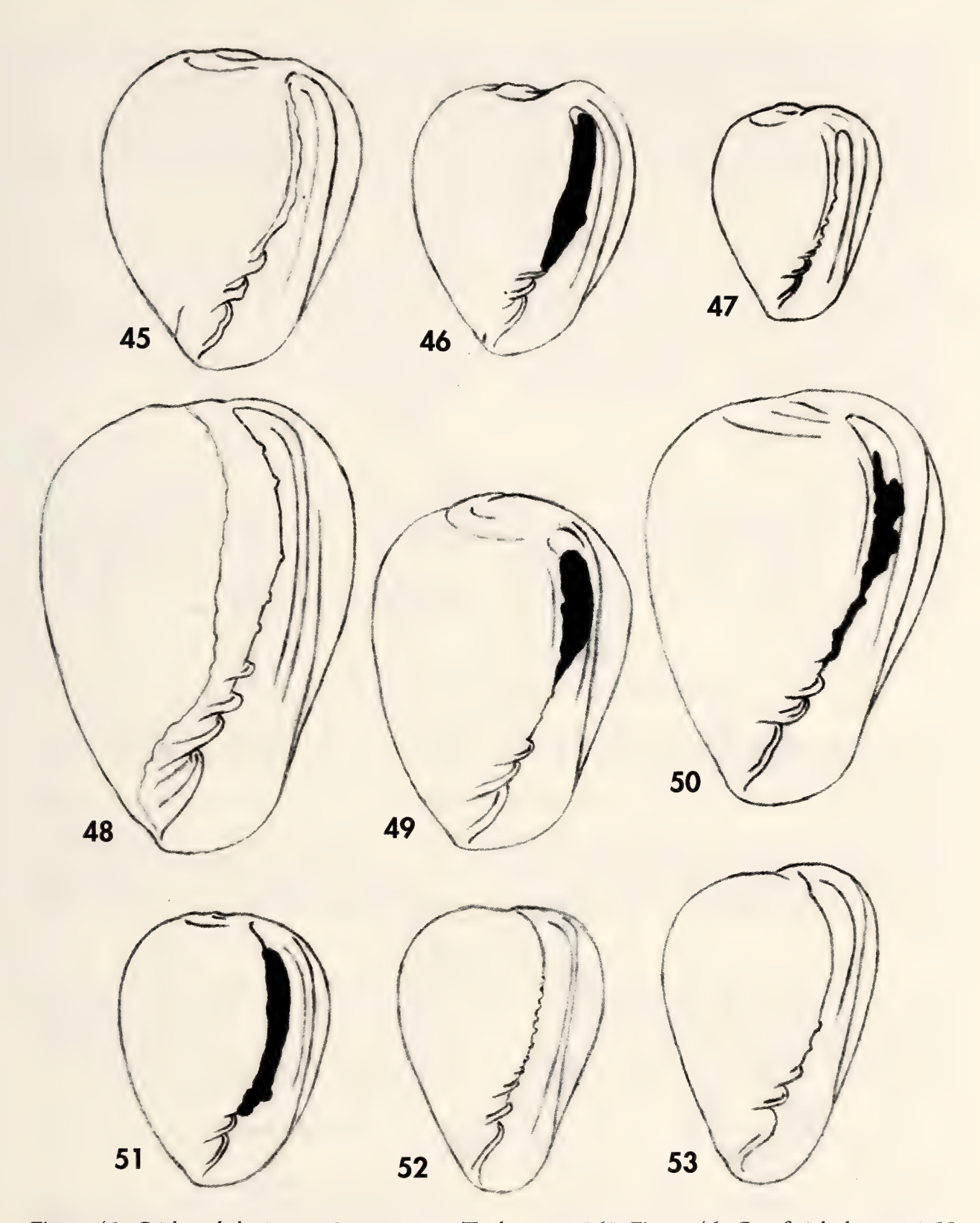


Figure 45: *Crithe caledonica*, 1.75 x 1.30 mm, Touho, stn 1269. Figure 46: *C. gofasi*, holotype, 1.55 x 1.10 mm, Touho, stn 1270 (MNHN). Figure 47: *Cystiscus minor*, holotype, 1.2 x 0.8 mm, Touho, stn 1271 (MNHN). Figures 48-50: *C. goubini*; 48: ex auct, 2.3 x 1.4 mm (MNHN); 49: 2.00 x 1.35 mm, Touho, stn 1269; 50: 1.90 x 1.25 mm, Koumac, stn 1318. Figure 51: *C. pardus*, holotype, 1.55 x 1.00 mm, Koumac, stn 1318 (MNHN). Figure 52: *C. deltoides*, holotype, 1.50 x 0.95 mm, Koumac, stn 1331 (MNHN). Figure 53: *C. caeruleus*, holotype, 1.7 x 1.0 mm, Touho, stn 1270 (MNHN).
Figura 45: Crithe caledonica, *1,75 x 1,30 mm, Touho, stn 1269. Figura 46:* C. gofasi, *holotipo, 1,55 x 1,10 mm, Touho, stn 1270 (MNHN). Figura 47:* Cystiscus minor, *holotipo, 1,2 x 0,8 mm, Touho, stn 1271 (MNHN). Figuras 48-50:* C. goubini*; 48: ex auct, 2,3 x 1,4 mm (MNHN); 49: 2,00 x 1,35 mm, Touho, stn 1269; 50: 1,90 x 1,25 mm, Koumac, stn 1318. Figura 51:* C. pardus, *holotipo, 1,55 x 1,00 mm, Koumac, stn 1318 (MNHN). Figura 52:* C. deltoides, *holotipo, 1,50 x 0,95 mm, Koumac, stn 1331 (MNHN). Figura 53:* C. caeruleus, *holotipo, 1,7 x 1,0 mm, Touho, stn 1270 (MNHN).*

Other material studied: Expedition Montrouzier, Touho, 1993: stn 1271, 20° 52.7′ S, 165° 19.5′ E, 5-25 m, 6 ad spm (Fig. 55); stn 1272, 20° 49.5′ S, 165° 19.6′ E, 10 m, 1 ad spm (Fig. 76). Expedition Montrouzier, Koumac, 1993: stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, 1 ad spm.
Type locality: Noumea area, Great Reef Aboré, 22° 22.21′ S, 166° 16.15′ E, 15-35 m, outer slope.
Etymology: For Bruce Marshall (NMNZ) who cooperated with P. Bouchet during the Noumea Expedition in November 1992, in which this species was first collected.

Shell description (Fig. 33): Translucent white, slender, light, suboval. Spire merged into the insertion of the much elevated labrum. Aperture regularly opened, inner lip smooth, one large first columellar plait and two upper packed small ones.

Size: 1.8 x 1.0 mm.

Animal description (Fig. 41): Bifurcated head with medium sized frontal lobes, foot small. Head yellow with a long axial reddish band running from each frontal lobe to the base of the head, passing between the eye and the central slit. Eyes red. Foot light yellow. Inner mantle uniformly deep yellow.

Distribution: Known from Noumea, Touho and Koumac, the species is supposed to range all around the NC mainland. Alive from 5 to 20 m.

Habitat: Not recorded.

Remarks: The shell as well as the animal of *C. marshalli* show as very constant. The animal of *C. montrouzieri* presents some similarities. However the shells of both species are noticeably divergent in several respects, and a close relationship is not evident.

Cystiscus boucheti sp. nov. (Figs. 34, 42)

Type material: Holotype (Figs. 34, 42) in MNHN. Noumea, stn 1343. Paratypes 7 ad and 1 subad spm from the type locality, in MNHN.
Other material studied: Noumea, 1992: Lagoon, Maitre Islet, 22° 20.41′ S, 166° 25.69′ E, low tide, 10 ad spm.
Type locality: Noumea area, Senez Reef, stn 1343, 22° 17.8′ S, 166° 19.9′ E, 7 m, inner slope.
Etymology: For Philippe Bouchet (MNHN), who led the coastal campaigns which procured the material studied in this article, and who pictured valuable descriptive sketches of live cystiscids in Noumea.

Shell description (Fig. 34): Translucent white, light, regular slender oval outline, narrow. Aperture very long and narrow, contracted in its mid-part, no apex. Outer lip thin and smooth, straight in its lower $^{2}/_{3}$ parts and arched upper. Two first columellar strong plaits, a third one faint, four small columellar varix occupy the half part of the remaining parietal wall.

Size: 1.4 x 0.8 mm.

Animal description (Fig. 42): Bifurcated head with long frontal lobes, foot small and triangular. Head light pinkish orange, eyes red. Foot pink with a darker axis on the metapodium. Inner mantle coloured by large packed pinky white and chocolate brown layers.

Distribution: Only known from two stations off Noumea. Alive from intertidal to 7 m.

Habitat: Not recorded.

Remarks: According to the field notes by P. Bouchet, the colour pattern of the animal is much constant, even if the inner mantle is more patchy in some specimens.

Cystiscus sp. 1 (Fig. 43)

In his drawing NC 14 (Noumea area, Ile aux Canards, 18 m, 1992-06-30), P. Bouchet pictured an animal comparable to *C. boucheti*, but showing also some constant differences even in the one station where both forms were observed as living in micro-sympatry (Senez Reef, 7 m, 1992-09-07). The corresponding

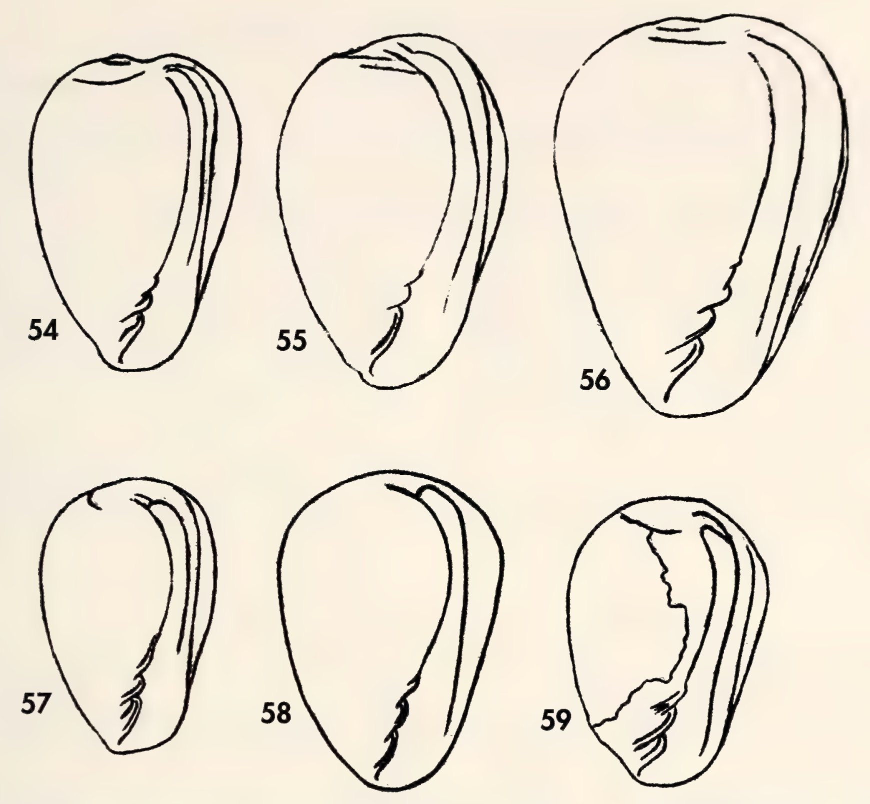


Figure 54: *Cystiscus tricinctus*, holotype, 1.60 x 0.95 mm, Touho, stn 1269 (MNHN). Figure 55: *C. marshalli*, 1.65 x 0.95 mm, Touho, stn 1271. Figure 56: *C. pseudoaurantius*, holotype, 1.9 x 1.3 mm, Touho, stn 1255 (MNHN). Figure 57: *C. cooverti*, holotype, 1.40 x 0.85 mm, Koumac, stn 1312 (MNHN). Figure 58: *C. bougei*, lectotype, 1.4 x 1.0 mm, Wallis (MNHN). Figure 59: *C. bougei*, 1.35 x 0.85 mm, Koumac, stn 1279.

Figura 54: Cystiscus tricinctus, *holotipo, 1,60 x 0,95 mm, Touho, stn 1269 (MNHN). Figura 55:* C. marshalli, *1,65 x 0,95 mm, Touho, stn 1271. Figura 56:* C. pseudoaurantius, *holotipo, 1,9 x 1,3 mm, Touho, stn 1255 (MNHN). Figura 57:* C. cooverti, *holotipo, 1,40 x 0,85 mm, Koumac, stn 1312 (MNHN). Figura 58:* C. bougei, *lectotipo, 1.4 x 1.0 mm, Wallis (MNHN). Figura 59:* C. bougei, *1,35 x 0,85 mm, Koumac, stn 1279.*

specimens from both stations were packaged separately in the field, but the lots corresponding to *Cystiscus* sp. seem to have been lost later.

Animal description (Fig. 43): Bifurcated head with medium size frontal lobes, foot small. Head and foot pink. Eyes red. Inner mantle made of a large alternated zone of chocolate brown and pink, this last zone being bordered by a narrow white fringe.

Remarks: In his field notes, P. Bouchet insists on the fact that the colour pattern of the inner mantle is constant in this form, and that it can be distinguished from *C. boucheti* by several features: its size is smaller, its foot is more uniformly pink coloured, the clear zones of its inner mantle are pink with a white fringe, and not uniformly pinky white.

In these conditions, it can be assumed that two sibling species are occurring here. Waiting for the rediscovery (or new recolts) of *Cystiscus* sp. 1 specimens, this morph is kept as an unnamed species.

Cystiscus camelopardalis sp. nov. (Figs. 35, 44)

Type material: Holotype (Figs. 35, 44) in MNHN. Noumea, stn 1336. 3 paratypes: 2 ad and 1 juv spm, in MNHN.
Type locality: Noumea area, Ile aux Canards, stn 1336, 22° 19.0′ S, 166° 26.1′ E, 18 m, boulders and sargasses.
Etymology: From the chromatism of the soft parts, with black subquadrate patches on a yellow ground, similar to the coat decoration of the giraffe (Latin form = *camelopardalis*).

Shell description (Fig. 35): Translucent white, slender cylindrical. Small produced spire, teat-like apex, aperture narrow, moderately widened to the base, labrum straight, inner lip smooth, two long anterior columellar plaits and a faintly produced third one.

Size: 1.0 x 0.7 mm.

Animal description (Fig. 44): Bifurcated head with long sized frontal lobes, foot very small and narrow. Head and foot deep yellow, eyes red. Inner mantle deep yellow with deep black irregular slabs.

Distribution: Only known by one lot from Noumea area. Alive in 18 m.

Habitat: Not recorded.

Remarks: By its shell as well as its animal chromatism, *C. camelopardalis* sp. nov. shows as very distinct from all the other species of *Cystiscus*.

Cystiscus minor sp. nov. (Figs. 47, 68, 69)

Type material: Holotype (Fig. 47) in MNHN. Touho, stn 1271. Paratypes: 8 ad and 1 juv spm from the type locality, in MNHN.
Other material studied: Expedition Montrouzier, Touho, 1993: stn 1259, 20° 44.6′ S, 165° 13.7′ E, 15-35 m, 1 ad spm (Fig. 68); stn 1270, 20° 45′ S, 165° 16.5′ E, 10-35 m, 4 ad spm; stn 1271, 20° 52.7′ S, 165° 19.5′ E, 5-25 m, 1 ad spm (Fig. 69).
Expedition Montrouzier, Koumac, 1993: stn 1310, 20° 39.7′ S, 164° 14.9′ E, 15 m, 3 ad and 1 juv spm; stn 1312, 20° 40.4′ S, 164° 14.9′ E, 26-40 m, 21 ad and 1 juv spm, 2 ad sh; stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20 -30 m, 2 ad and 1 juv spm.
Type locality: Touho area, Tié shallows, stn 1271, 20° 52.7′ S, 165° 19.5′ E, 5-25 m, cliffs, sand on rocky floor.
Etymology: From the small size of the species.

Shell description (Fig. 47): Translucent white, short, subtriangular. Spire faintly produced, teat-like protoconch, labrum elevated and arched in its upper part, straight in its central and lower part. Aperture narrow, faintly widening to the base, inner lip smooth, three anterior columellar plaits and seven faint parietal varix.

Size: 1.2 x 0.8 mm.

Animal description (Fig. 68): Bifurcated head with short frontal lobes, foot small and triangular. Head whitish fringed with light orange, more reddish around the central slit. Eyes red. Foot mottled opaque white. Inner mantle whitish with beige shades.

Distribution: Known from Touho and Koumac, in north of the NC mainland. Alive from 5 to 26 m, empty shells at 26 m.

Habitat: Not recorded.

Remarks: In its northern distribution, *C. minor* sp. nov. seems to be rather common and live in somewhat dense populations.

The shell morphology is constant, but the chromatism of the animal somewhat variable (Figs. 68, 69). The light orange zones on the head periphery may be replaced by creamy yellow zones restricted to the frontal lobes. The reddish fringes may be very narrowed and also restricted to the frontal lobes.

The foot may be mottled light yellow better than white, with a fine red fringe ahead. The inner mantle may be deep white.

About specimens observed from Mangalia Reef (Touho), S. Gofas noted that the head may be "more or less orange".

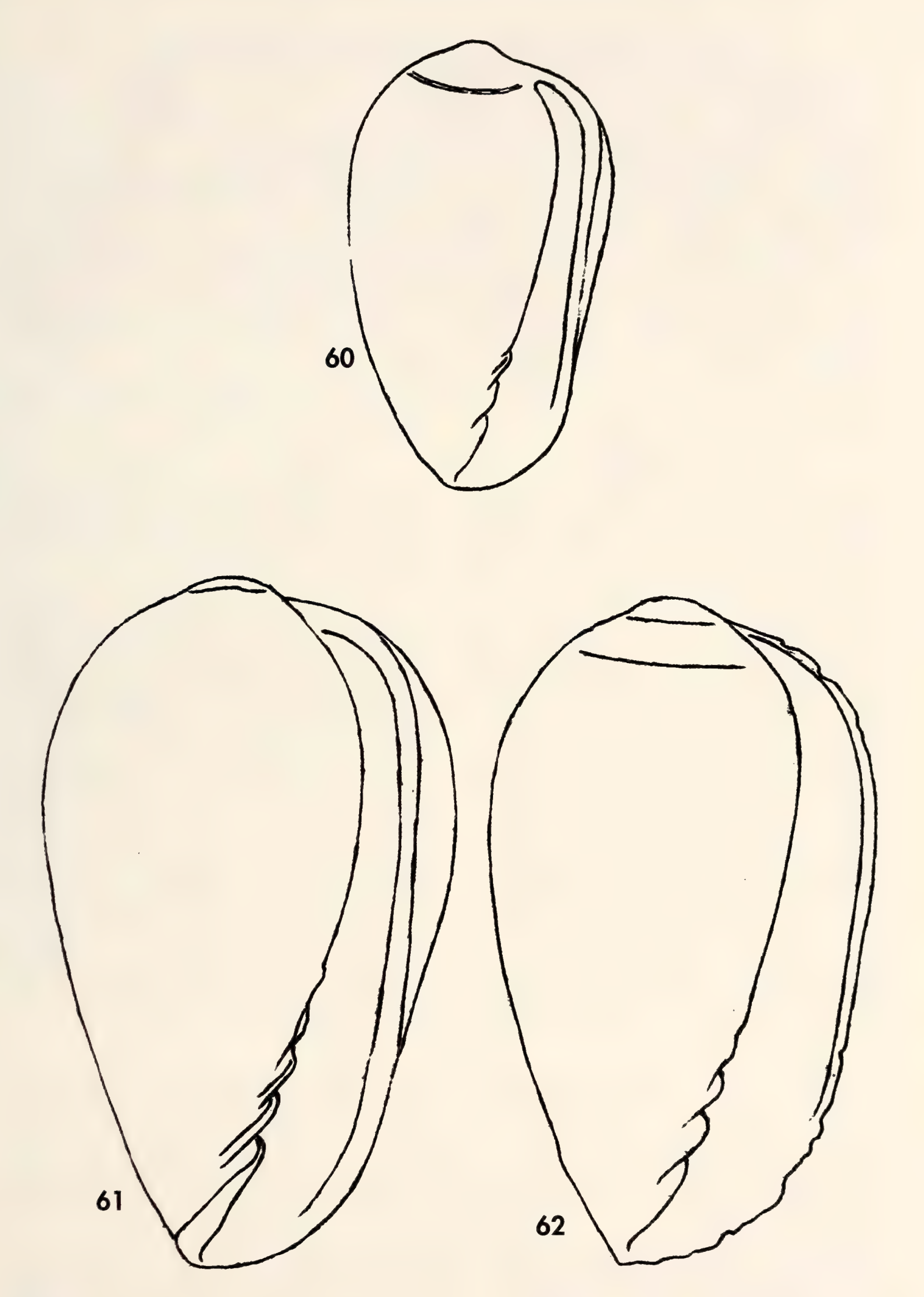


Figure 60: *Plesiocystiscus tomlini*, lectotype, 2.20 x 1.25 mm, Ouvea, Wallis Is. (MNHN). Figures 61, 62. *P. bavayi*. 61: holotype, 3.30 x 1.95 mm, Touho, stn 1261 (MNHN); 62: 3.10 x 1.70 mm, Touho, stn 1271.

Figura 60: Plesiocystiscus tomlini, *lectotipo, 2.20 x 1.25 mm, Ouvea, Wallis Is. (MNHN). Figuras 61, 62.* P. bavayi. *61: holotipo, 3.30 x 1.95 mm, Touho, stn 1261 (MNHN); 62: 3.10 x 1.70 mm, Touho, stn 1271.*

Cystiscus goubini (Bavay, 1922) (Figs. 48-50, 70, 71)

Marginella goubini Bavay, 1922, p. 60-61, pl. I, fig. 10

Type material: Holotype said to be lost (ROTH and CLOVER, 1973: 211).
Other material studied: MDC: 11 ad sh (Fig. 48), labelled "Goubini" from the hand of Bavay.
Expedition Montrouzier, Touho, 1993: stn 1269, 20° 35.1′ S, 165° 08.1′ E, 15-20 m, 3 ad spm (Fig. 49, 70); stn 1271, 20° 52.7′ S, 165° 19.5′ E, 5-25 m, 3 juv spm.
Expedition Montrouzier, Koumac, 1993: stn 1299, 20° 34.4′ S, 164° 13.0′ E, 12-14 m, 1 ad spm; stn 1312, 20° 40.4′ S, 164° 14.9′ E, 26-40 m, 5 ad and 2 juv spm 2 ad sh; stn 1316, 20° 40′ S, 164° 11.2′ E, 12 m, 10 ad and 2 juv spm, 4 ad sh; stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-40 m, 4 ad and 3 juv spm, 1 ad sh, (Figs. 50, 71); stn 1319, 20° 44.7′ S, 164° 15.5′ E, 15-20 m, 5 ad and 2 juv spm; stn 1331, 20° 40-20° 40.6′ S, 164° 11.2′-164° 12.1′ E, 55-57 m, 1 ad sh.
Expedition Lifou 2000: stn 1429, 20° 47.5′ S, 167° 07.1′ E, 8-18 m, 1 ad spm, 2 ad sh; stn 1436, 20° 55.5′ S, 167° 04.2′ E, 10-20m, 4 ad sh; stn 1442, 20° 46.4′ S, 167° 02.0′ E, 47 m, 2 ad sh.
Type locality: Lifou.

Shell description (Fig. 48): White, solid, egg-shaped outline, inflated, faintly pyriform. Aperture long and narrow, much widening to the base. Outer lip thick and rounded in its upper part, thin and flexuous in its lower part. Two strong anterior columellar plaits, two next ones fainter, and six regular spaced lirations along the parietal border.

Size: 1.9 to 2.3 mm x 1.25 to 1.40 mm.

Animal description (Figs. 70, 71): Bifurcated head with medium sized frontal lobes, foot medium sized and triangular. The borders of the head are light orange, more pronounced along the central slit, on a whitish to yellow background. Eyes red. The foot is opaque greyish to dirty white, a fine orange vein may run ahead. Inner mantle greyish blue, paving pattern of irregular figures. External mantle is mottled greyish blue with an irregular surface.

Distribution: Known from Lifou (type locality) and from northern NC (Touho and Koumac). Alive from 5 to 26 m, empty shells from 8 to 55 m.

Habitat: Hard bottoms.

Remarks: The shell of *C. goubini* (Bavay, 1922) is distinct by its large size and its bulbous shape. The animal chromatism differs noticeably from all the other NC species, except from the species considered hereunder.

Due to the poor datum joined to the lot of C.*goubini* found in the Bavay's collection, and to the absence of a "TYPE" label, the status of this lot as type material is not ascertained. The designation of a neotype is provisionally refrained, waiting for the possible rediscovery of such a type lot within a public institution, for instance in the Dautzenberg Collection, IRSNB.

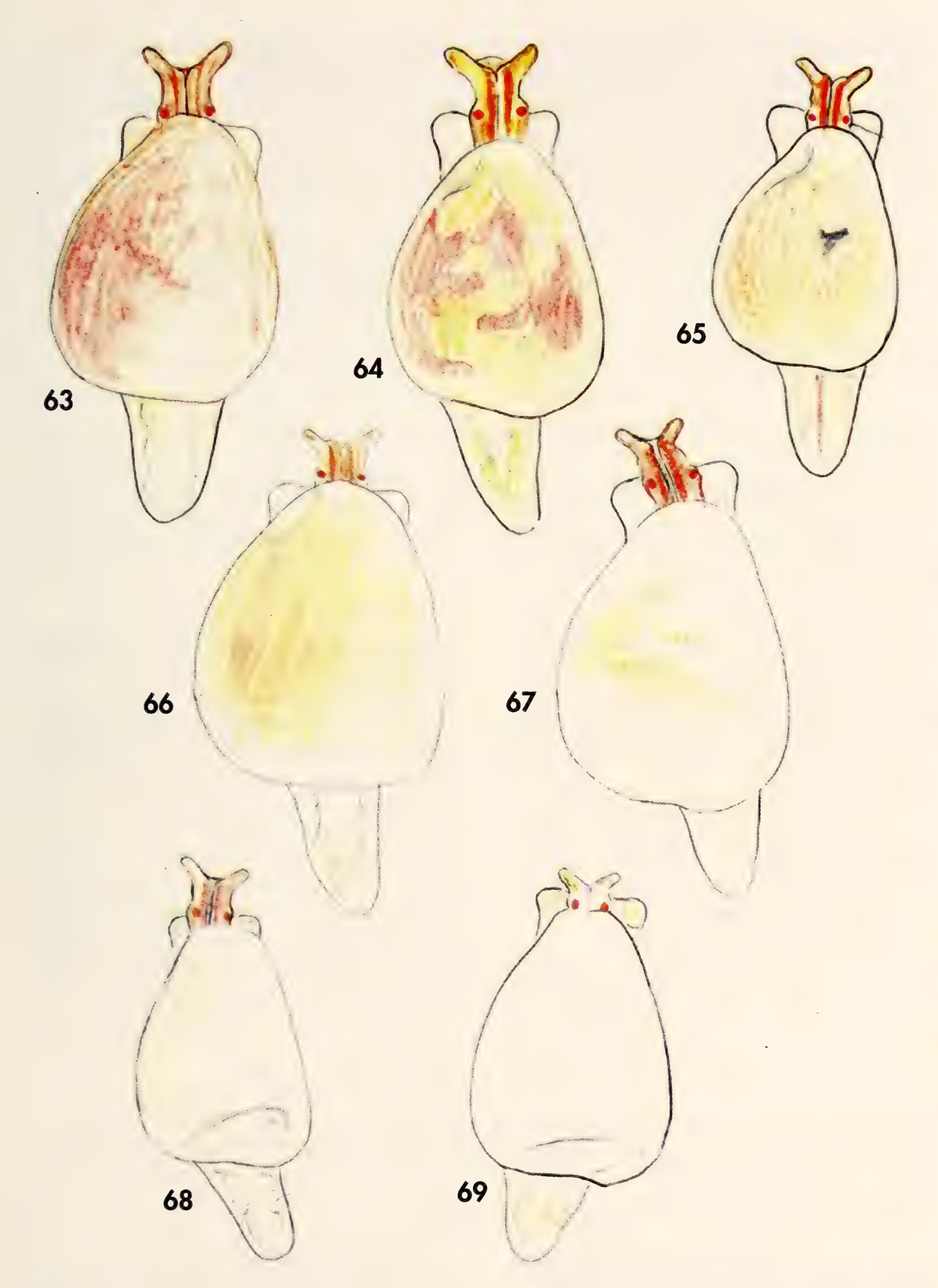
Cystiscus pardus sp. nov. (Figs. 51, 72)

Type material: Holotype (Figs. 51, 72) in MNHN. Koumac, stn 1318. 1 paratype (ad spm) from the type locality, in MNHN.
Other material studied: Expedition Montrouzier, Koumac, 1993: stn 1319, 20° 44.7′ S, 164° 15.5′ E, 15-20 m, 3 ad spm.
Type locality: Koumac area, Barrier Reef, stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, outer slope.
Etymology: From the leopard patterned inner mantle of the animal.

Shell description (Fig. 51): Translucent white, egg-shaped, inflated, faintly pyriform. Spire flat, labrum arched, inner lip smooth, three anterior columellar plaits.

Size: 1.55 x 1.00 m.

Animal description (Figs. 72): Bifurcated head with short frontal lobes, foot small and triangular. Head fringed with light orange on a whitish and yellowish ground. Eyes red. Foot covered with large clouds of light yellowish to



Figures 63, 64: *Crithe caledonica*. 63: Koumac, stn 1316, (NC 657); 64: Touho, stn 1269 (NC 328). Figure 65: *C. gofasi*, holotype, Touho, stn 1270 (NC 329). Figures 66, 67: *C. caledonica*. 66: Koumac, stn 1318 (NC 648); 67: Touho, stn 1259 (NC 301). Figures 68, 69: *Cystiscus minor*. 68: Touho, stn 1259 (NC 302); 69: Touho, stn 1271 (NC 372).

Figuras 63, 64: Crithe caledonica. *63: Koumac, stn 1316, (NC 657); 64: Touho, stn 1269 (NC 328). Figura 65:* C. gofasi, *holotype, Touho, stn 1270 (NC 329). Figuras 66, 67.* C. caledonica. *66: Koumac, stn 1318 (NC 648); 67: Touho, stn 1259 (NC 301). Figuras 68, 69.* Cystiscus minor. *68: Touho, stn 1259 (NC 302); 69: Touho, stn 1271 (NC 372).*

opaque white. Inner mantle light yellowish decorated with packed and disorganized small leopard-patterned greyish blue marks. The zone under the spire is light brown, surrounded by light yellow.

Distribution: Only known from 2 stations off Koumac, NW of NC mainland. Alive from 15 to 20 m.

Habitat: Not recorded.

Remarks: *C. pardus* sp. nov. is very similar to *C. goubini*. However, both species were collected and observed in micro-sympatry (stn 1318) and they display constant differences. The shell of *C. pardus* is smaller and more rounded. The foot is yellowish to opaque white better than dirty white. The inner mantle has a yellow ground versus a greyish-blue one, and shows irregular fragmented greyish blue marks versus rounded whitish grey-blue ones. The head decoration is identical in both species, suggesting a close relationship.

Cystiscus deltoides sp. nov. (Fig. 52)

Type material: Holotype (Fig. 52) in MNHN. Koumac, stn 1331. 1 paratype (ad sh) from the type locality, in MNHN.
Type locality: Koumac area, Great Reef, stn 1331, 20° 40′-20° 40.6′ S, 164° 11.2′-164° 12.1′ E, 55-57 m, outer slope.
Etymology: From the subtriangular outline of the shell.

Shell description (Fig. 52): Opaque white, light, slender, subtriangular, upper part inflated, tapering to the base. Spire flat, upper half part of the labrum arched, shoulder slightly elevated, lower half of the labrum oblique, inner lip straight and smooth. Three distinct anterior columellar plaits, eight visible small upper parietal varix. Aperture moderatly narrowed, slightly widening to the base.

Size: 1.50 x 0.95 mm.

Animal: Unknown.

Distribution: Only known by one lot of two shells dredged off Koumac, NW of NC mainland. Alive in 55 m.

Habitat: Not recorded.

Remarks: *C. deltoides* sp. nov. shows some similarities with *C. punctatus* as well as with the species described hereunder, as far as shell features are concerned. *C. deltoides* has however a more triangular outline than *C.punctatus*, and has a less slender outline and a less elevated labrum than the following species. *C. deltoides* may have a deeper bathymetric distribution than the other species studied herein.

Cystiscus caeruleus sp. nov. (Figs. 53, 74)

Type material: Holotype (Fig. 53, 74) in MNHN. Touho, stn 1270.
Type locality: Touho area, Great Reef Mangalia, stn 1270, 20° 45′ S, 165° 16.5′ E, 10-35 m, outer slope.
Etymology: From the blue inner mantle of the animal.

Shell description (Fig. 53): Translucent white, light, slender, subtriangular, upper part inflated. Spire flat, upper part of the labrum arched and much elevated, central and lower labrum straight. Three distinct anterior columellar plaits, two small upper parietal varix. Aperture much narrow, hardly opened to the base.

Size: 1.7 x 1.0 mm.

Animal description (Fig. 74): Bifurcated head with short frontal lobes, foot small. Head and foot orange, inner mantle blue.

Distribution: Only known by 1 spm from Touho, NE of NC mainland. Alive in 10 m.

Habitat: Not recorded.

Remarks: The shell of *C. caeruleus* sp. nov. shows some similarities with *C. deltoides* and with the species described hereunder. Its animal presents a much original bicoloured chromatism.

Cystiscus tricinctus sp. nov. (Figs. 54, 75)

Type material: Holotype (Fig. 54, 75) in MNHN. Touho, stn 1269. 4 paratypes (ad spm) from the type locality, in MNHN.
Type locality: Touho area, Doiman Reef, stn 1269, 20° 35.1′ S, 165° 08.1′ E, 15-20 m, outer slope.
Etymology: From the tribanded decoration of the inner mantle.

Shell description (Fig. 54): Translucent white, slender, light, suboval. Spire very small, low teat-like protoconch, upper labrum arched, shoulder moderately elevated, central and lower labrum straight, aperture narrow, faintly widening to the base, three columellar plaits.

Size: 1.60 x 0.95 mm.

Animal description (Fig. 75): Bifurcated head with short massive frontal lobes, foot small and triangular. Head light green, eyes red. Foot mottled opaque white. Inner mantle yellow with three black spiral bands, the anterior one being U-shaped. External mantle translucent.

Distribution: Only known from one station in Touho, NE of NC mainland. Alive in 15 m.

Habitat: Not recorded.

Remarks: The shell of *C. tricinctus* sp. nov. shows some similarities with that ones of *C. caeruleus* and of *C. punctatus*. However, it is more oval and less shouldered than *C. caeruleus* and it is more slender than *C. punctatus*, with a narrower aperture. The animal of *C. tricinctus* is also much different from that one of these two species.

Cystiscus pseudoaurantius sp. nov. (Figs. 56, 77)

Type material: Holotype (Fig. 56, 77) in MNHN. Touho, stn 1255. 1 paratype (ad spm) from the type locality, in MNHN.
Other material studied: Expedition Montrouzier, Touho, 1993: stn 1270, 20° 45′ S, 165° 16.5′ E, 10-35 m, 5 ad spm; stn 1271, 20° 52.7′ S, 165° 19.5′ E, 5-25 m, 2 ad spm.
Expedition Montrouzier, Koumac, 1993: stn 1316, 20° 40′ S, 164° 11.2′ E, 12 m, 5 ad and 1 subad spm.
Type locality: Touho area, Ouao Islet, stn 1255, 20° 43′ S, 165° 08′ E, 11 m, sand, detritic domes.
Etymology: As distinct from *C. aurantius* a congeneric species which has also an orange coloured animal.

Shell description (Fig. 56): Translucent white, solid, subtriangular, wide. Spire hardly pronounced, upper labrum arched, shoulder slightly elevated, lower labrum straight, inner lip straight and smooth, aperture moderately narrow, faintly widening to the base, three strong anterior columellar plaits and a tiny fourth upper one.

Size: 1.9 x 1.3 mm.

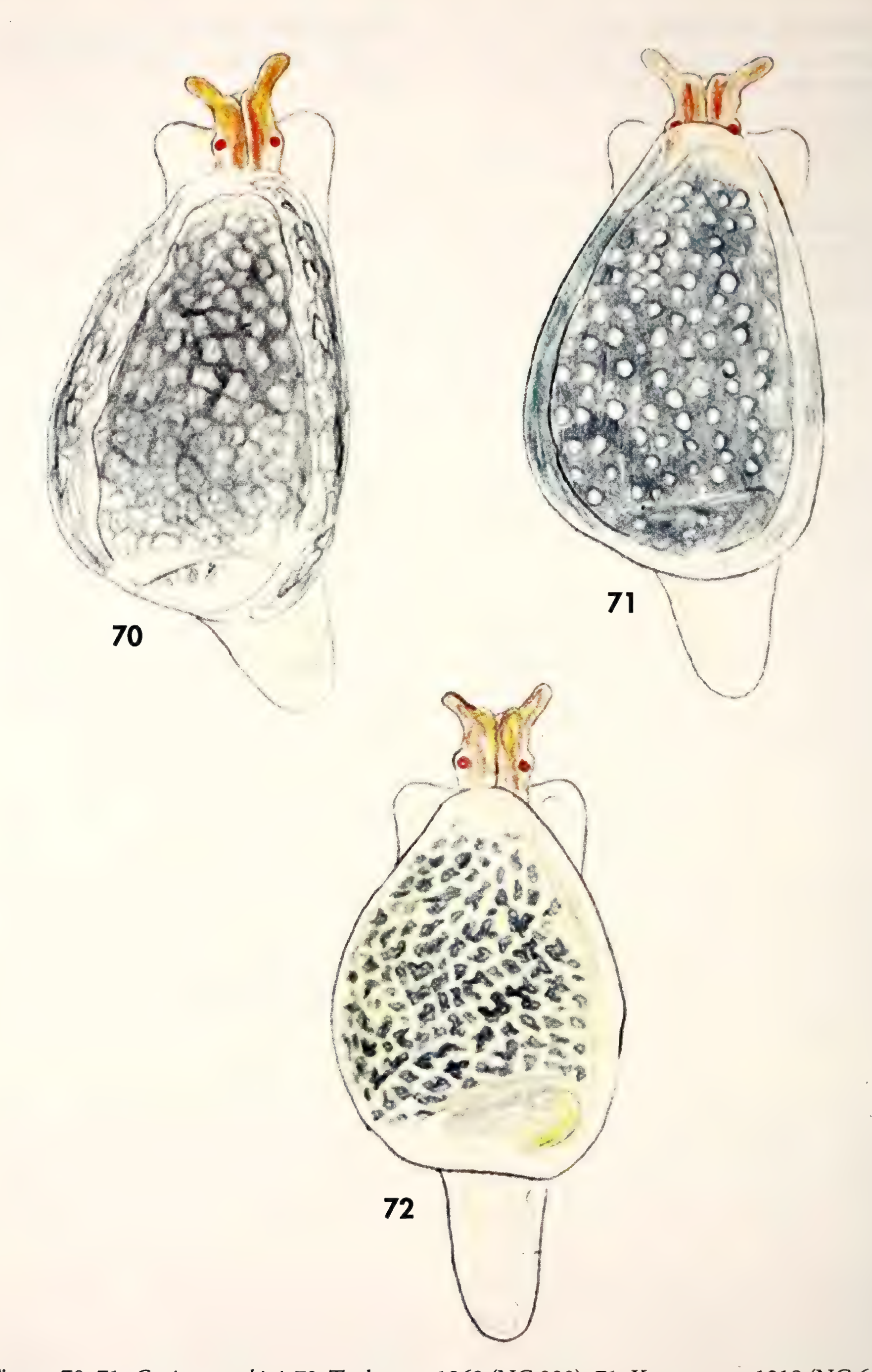
Animal description (Fig. 77): Bifurcated head with long frontal lobes, foot medium sized, triangular. Head light orange with a wide red fringe along the central slit, frontal lobes red, eyes red. Foot and external mantle light orange, inner mantle beige.

Distribution: Known from Touho and Koumac, northern NC mainland. Alive from 5 to 12 m.

Habitat: The type material comes from detritic sandy places.

Remarks: The shell of *C. pseudoaurantius* sp. nov. is distinct from its relatives by its large size, wide and massive proportions, subtriangular rounded outline.

The animal is distinct from *C. aurantius* by the red marks on its head and by the deeper orange colour ground of both head and foot.



Figures 70, 71. *Cystiscus goubini*. 70: Touho, stn 1269 (NC 330); 71: Koumac, stn 1318 (NC 646). Figure 72: *C. pardus*, holotype, Koumac, stn 1318 (NC 647).
Figuras 70, 71. Cystiscus goubini. *70: Touho, stn 1269 (NC 330); 71: Koumac, stn 1318 (NC 646). Figura 72:* C. pardus, *holotipo, Koumac, stn 1318 (NC 647).*

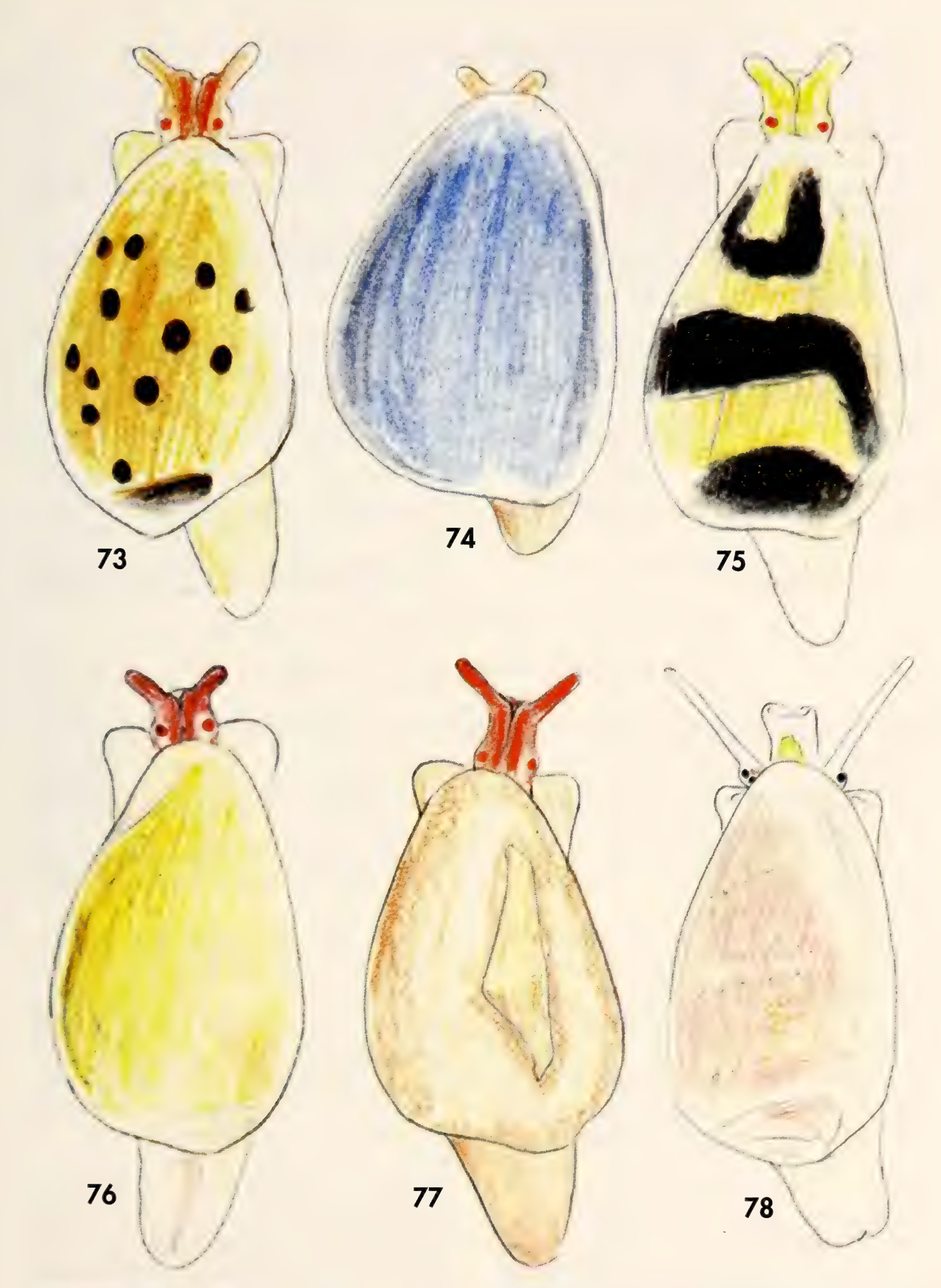


Figure 73: *Cystiscus punctatus*, Koumac, stn 1318 (NC 649). Figure 74: *C. caeruleus*, holotype, Touho, stn 1270 (NC 390). Figure 75: *C. tricinctus*, holotype, Touho, stn 1269 (NC 331). Figure 76: *C. marshalli*, Touho, stn 1272 (NC 348). Figure 77: *C. pseudoaurantius*, holotype, Touho, stn 1255 (NC 322). Figure 78: *Plesiocystiscus bavayi*, Touho, stn 1271 (NC 359).

Figura 73: Cystiscus punctatus, *Koumac, stn 1318 (NC 649). Figura 74:* C. caeruleus, *holotipo, Touho, stn 1270 (NC 390). Figura 75:* C. tricinctus, *holotipo, Touho, stn 1269 (NC 331). Figura 76:* C. marshalli, *Touho, stn 1272 (NC 348). Figura 77:* C. pseudoaurantius, *holotipo, Touho, stn 1255 (NC 322). Figura 78:* Plesiocystiscus bavayi, *Touho, stn 1271 (NC 359).*

Cystiscus cooverti sp. nov. (Fig. 57)

Type material: Holotype (Fig. 57) in MNHN. Koumac, stn 1312. 2 paratypes (ad spm) from the type locality, in MNHN.
Other material studied: Expedition Montrouzier, Koumac, 1993: stn 1310, 20° 39.7′ S, 164° 14.9′ E, 15 m, 3 ad spm; stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, 2 ad and 1 subad spm; stn 1319, 20° 44.7′ S, 164° 15.5′ E, 15-20 m, 1subad spm.
Type locality: Koumac area, Pass, east cliff, stn 1312, 20° 40.4′ S, 164° 14.9′ E, 26-40 m, hard bottoms.
Etymology: For Gary Coovert, who devoted deep studies in marginellid gastropods during the last twenty years, and who made a first selection work on the material studied here.

Shell description (Fig. 57): Translucent white, light, slender oval, spire merging into the insertion of the outer lip, high shouldered arched upper labrum, lower part sinuous, narrow aperture slightly widening to the base, two anterior oblique columellar plaits, one upper subvertical third one.

Size: 1.40 x 0.85 mm.

Animal: Unknown.

Distribution: Only known from four stations in Koumac, NW of NC mainland. Alive from 15 to 26 m.

Habitat: Hard bottoms.

Remarks: Despite the unknown animal, the shell characters are sufficient here for a distinction at the specific level, based on the moderate size, the slender oval ouline, the sinuous elevated labrum and the subvertical third columellar plait.

Cystiscus bougei (Bavay, 1917) (Figs. 58, 59)

Marginella bougei Bavay, 1917, p. 103-104, pl. II, fig. 3 (uncorrect picture). Bavay, 1922, p. 58, pl. I, Figs. 6-7 (correct pictures).

Type material: Lectotype (Fig. 58) in MNHN. Labels: "*Marginella (Granula) Bougei* cotypes. Iª Wallis"; "*Marginella Bougei*. Iª Wallis. types".
The lectotype was selected by Roth and Clover (1973: 209), under ICZN (74b). Five other sh belonging to the same lot were later separated by G. Coovert as two *Cystiscus iota* (Hedley, 1899) and three *Cystiscus* sp.
One lot of 43 sh and fr was found in MDC (MNHN) with the labels: "*Ma Granula Bougei* I. Wallis Sables", from the hand of Bavay, and "TYPE" in typed red letters. These shells are now joined to the type lot as paralectotypes.
Other material studied: Expedition Montrouzier, Koumac, 1993: stn 1277, 20° 34′ S, 164° 16′ E, 0-2 m, 1ad and 1 juv spm; stn 1279, 20° 35′ S, 164° 15.5′ E, tide, 10 ad and 4 juv spm (Fig. 59); stn 1282, 20° 33.5′ S, 164° 13′ E, tide, 1 ad spm; stn 1289, 20° 29.2′ S, 164° 10.2′ E, tide, 23 ad and 6 juv spm, 7 ad and 2 juv sh; stn 1292, 20° 22.4′ S, 164° 06.8′ E, tide, 2 ad and 1 juv sh; stn 1300, 20° 35.6′ S, 164° 15.2′ E, 10-11 m, 6 ad and 1 juv spm; stn 1303, 20° 37.7′-20° 38.8′ S, 164° 15.9′-164° 17.1′ E, 0-8 m, 1 ad sh; -Koumac area, Rat Islet, 20° 33.7′ S, 164° 11′ E, tide, 20 ad and 1 juv sh.
Type locality: Ouvea, Wallis Islands.

Shell description (Fig. 58): White, light, slender egg-shaped outline, tapering to the base. Outer lip sloping down in its upper part, thickened and bulging in its central part, slightly flexuous in its lower part. Long aperture, moderately widening to the base, three oblique columellar plaits.

Size: 1.4 x 1.0 mm.

Animal: Unknown. One of the spm from the stn 1279 is labelled as corresponding to the drawing NC 639 by S. Gofas. However, this drawing shows an animal with well-pronounced rounded pustules on the external mantle, this character being common in *Granulina*, but not recorded in *Cystiscus*. The soft parts chromatism pictured in NC 639 matchs the one of a species attributable to *Granulina* (Boyer, in press c). Furthermore, the foot of the dried animal said to be pictured in NC 639 clearly shows a festoon of black

patches, whereas such a decoration is not represented in NC 639. So, it seems evident that an inversion of sketches references led to the loss of the picture of *C.* cf *bougei.*

Distribution: North West NC to Wallis Islands. Alive from intertidal to 10 m, empty shells in intertidal. BAVAY (1917: 103) recorded a smaller form as ranging in Tonga Islands.

Habitat: Live spm are recorded from soft bottoms with grass.

Remarks: *C. bougei* appears as common and somewhat abundant in very shallow waters of Koumac, whereas it seems to be lacking in low tide brushings made off Noumea and Touho. However, tide samplings seem to have been more frequent in Koumac. The shell variability observed in Koumac overlaps in the main the shell variability observed in Wallis.

The distribution of a species of *Cystiscus* from northern NC to Wallis and Tonga cannot be considered as impossible, even if the occurrence of the species in eastern NC, in Loyalty and in the New Hebrids remains to be verified. The control of the animal chromatism in the different places would help greatly to precise the taxonomic status of the populations attributable to *C. bougei.*

Genus *Plesiocystiscus* Coovert and Coovert, 1995

Type species: *Marginella jewetti* Carpenter, 1857, by original designation.

Plesiocystiscus tomlini (Bavay, 1917) (Fig. 60)

Marginella tomlini, Bavay, 1917, p. 102-103, pl. II, fig. 7.

Type material: Lectotype (Fig. 60) and 3 paralectotypes (3 ad sh) in MNHN (ex-MDC). Labels: "Marginella Tomlini By Ouvea. I. Wallis, sables", from the hand of Bavay, and "TYPE" in typed red letters. No type material was found in MNHN by Clover (ROTH and CLOVER, 1973: 214).
Other material studied:
Expedition Montrouzier, Koumac, 1993: stn 1312, 20° 40.4′ S, 164° 14.9′ E, 26-40 m, 1 ad sh; stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, 1 ad sh.
Type locality: Ouvea, Wallis Islands.

Shell description (Fig. 60): White, solid, slender egg-shaped outline, spire short and faintly bulging, outer lip straight, aperture long and narrow, moderately widening to the base, three much oblique columellar plaits.

Size: 2.20 x 1.25 mm.

Animal: Unknown.

Distribution: Only known from Wallis Islands (type locality) and by the two comparable shells from Koumac, NW of NC mainland, sampled as empty shells from 20 to 26 m.

Habitat: Unknown.

Remarks: The two shells sampled off Koumac are slightly larger (L: 2.4 and 2.5 mm) than the types of *P. tomlini*, their columellar border is slightly more convex, and overall, they both present a small fourth columellar plait whereas the four types do not have.

Despite the fact that all the other shell features are similar in both phenae, they are probably distinct at a specific level.

Plesiocystiscus bavayi sp. nov. (Figs. 61, 62, 78)

Type material: Holotype (Fig. 61) in MNHN. Touho, stn 1261. 2 paratypes (1 subad spm and 1 ad sh) from the type locality, in MNHN.
Other material studied: Expedition Montrouzier, Touho, 1993: stn 1271, 20° 52.7′ S, 165° 19.5′ E, 5-25 m, 1 subad spm (Figs. 62, 78).

Expedition Montrouzier, Koumac, 1993: stn 1311, 20° 40.4′ S, 164° 14.9′ E, 10-60 m, 1 ad spm; stn 1314, 20° 39.8′ S, 164° 15.3′ E, 30-63 m, 2 ad sh; stn 1318, 20° 41.4′ S, 164° 14.8′ E, 20-30 m, 3 ad spm; stn 1319, 20° 44.7′ S, 164° 15.5′ E, 15-20 m, 1 ad spm; stn 1322, 20° 45.2′ S, 164° 15.2′ E, 53-71 m, 2 ad and 1 subad sh; stn 1331, 20° 40′-20° 40.6′ S, 164° 11.2′-164° 12.1′ E, 55-57 m, 2 ad sh.
Expedition Lifou 2000: stn 1442, 20° 46.4′ S, 167° 02.0′ E, 47 m, 1 ad sh; stn 1449, 20° 45.8′ S, 167° 01.65′ E, 17 m, 1 ad sh.

Type locality: Touho area, channel, stn 1261, 20° 46′-20° 47′ S, 165° 15′-165° 16.5′ E, 45-56 m, detritic sand.

Etymology: For Arthur Bavay (1840-1923), french conchologist who specially devoted to the study of small marginelliform gastropods in the earl XXth Century, and who performed the first revision of cystiscids from New Caledonia.

Shell description (Fig. 61): White, slender tear-shaped, upper part inflated, spire very small, rounded, aperture narrow, slightly widening to the base, inner lip long, straight and smooth, four distinct oblique columellar plaits, a fifth subvertical one is suggested.

Size: 3.30 x 1.95 mm.

Animal description (Fig. 78): Bilobed head, with two long tentacles, black eyes at their base on a swollen peduncle. Siphon wide and produced. Foot large and subrectangular. The back tip of the metapodium is truncated. Mentum distinct ahead of the foot.

Head, siphon and foot whitish translucent. A small orange stain and a black one at the level of the eye, a yellow patch at the centre of the siphon. Inner mantle light reddish with three spiral rings of yellow dots.

Distribution: Known from Touho and Koumac, northern NC mainland. Alive from 5 to 45 m, empty shells from 17 to 55 m.

Habitat: Detritic to silty sand as well as hard bottoms.

Remarks: One larger shell from Koumac (stn 1322, 53-71 m), sizing 3.75 mm in length, shows noticeably distinct features (more slender and cylindric outline, less opened aperture to the base, more concave first columellar plait, more produced spire), and must be provisionally considered as belonging to a different species, as *P.* sp. aff. *bavayi.*

CONCLUSION

In the course of this study, 28 morphs were recognized as belonging to the sublittoral Cystiscidae from NC mainland. Among them, 5 are referred to species previously described (one being referred with much reserves), 18 are described and named as new species, and 5 are recorded as potential new species. As such, the known diversity of the sublittoral Cystiscidae from NC is increased by a factor higher than x 5.

Nineteen of these 28 morphs belong to the group *Crithe/Cystiscus*. It can be assumed that much more species belonging to this group remain to be discovered at infralittoral levels from NC, by the fact that most of the species are represented by a very limited number of lots and subjects within the important material checked here. As far as the group *Crithe/Cystiscus* is concerned, eight morphs are represented by only one lot (six morphs by only one or two subjects), three morphs by only two lots, and only eight morphs among nineteen are represented by more than two lots.

In other words, the majority of the morphs belonging to *Crithe/Cystiscus* are represented by only one or two lots, and 30% of the total morphs are represented by only one or two subjects. From these elements, it can be inferred that the "sampling saturation" is far to be reached, and that deeper investigations within the sampled areas will very probably procure many new morphs.

The species composition does not show any evident correspondence with

the special environmental features represented within the four studied sites, and the results suggest that the endemism is very developed in NC *Crithe/Cystiscus*: among the nineteen studied morphs, ten are represented only from northern NC, six only from SW NC, and only three are represented in northern as well as southern stations (overlapping rate of only 16%). Even if it can be supposed that the number of widespread morphs is underestimated, the results allow to infer that some of the species may have a distribution restricted to few hundred kilometres of coast. As a consequence, each of the wide coastal zones which were not intensively checked (central West Coast, central and southern East Coast, Ile des Pins, far north lagoon and Belep Island) may shelter a set of endemic species.

In these conditions, the diversity of *Crithe/Cystiscus* displayed in this article cannot be considered as representative of the real diversity of this group in NC waters, which is probably much higher. It must be only considered as an indicator demonstrating that the group *Crithe/Cystiscus* is highly diversified in NC waters, and as a stimulating pretext to develop intensive samplings in other places of the NC coast, to intensify locally the sampling for a measure of effort/diversity output, and to correlate the faunal diversity at hand with the diversity of its sheltering micro-habitats in view to infer the real faunistic diversity.

The best use of the observations about the diversity is probably to play it as an argument in the reconstruction of an evolutionary history or as explanatory of a biogeographic context: this supposes appropriate ways and degrees of observations. In the case studied here, the principal deficiencies of the information seem to lie in the fact that micro-habitats attached to each species are not recorded (assessment of the sampling impact correlated to the micro-habitat diversity) and in the relative few number of live animal pictures compared to the high number of specimens collected (assessment of the global variability of the species and control of the specific diversity). In the case of *Cystiscus/Crithe*, made of numerous species with very similar shells but with very different and non-variable animals, the knowledge of the animal chromatism and external morphology is decisive for estimating the diversity at the specific level. In the case of the small white shelled *Gibberula*, that is the important variability of the shells and of the animals of some species which makes necessary to have recourse to the systematic observation of the live animals. Consequently, the best exploitability of the intensive samplings seems to require the notation in the field of precise data about the sampled micro-habitats, and the organization of intensive picturing of live animals.

The diversity of *Crithe/Cystiscus* observed in NC cannot be considered no more as a special occurrence restrictively attached to this area. In fact, the situation revealed in NC may as well be representative of a high diversity of *Crithe/Cystiscus* in Central West Pacific. The intensive samplings realized recently in NC constitute an innovation, and the rest of the Central West Pacific (even the intertropical australian coasts) waits for such a performance.

On the ground of the various morphs studied here, the genera *Crithe* and *Cystiscus* do not show as clearly distinct. It better seems that they both belong to a wide complex of forms which deserves to be unified under a common taxonomic group. However, this wide group will probably require taxonomic subdivisions corresponding to natural affinities, and it is conceivable that the generic unification of the group will be more correctly stated in the frame of a general reorganization rendering the diversity pattern working here.

ACKNOWLEDGEMENTS

Thanks are due to the members of the Expeditions Montrouzier 1993 and Lifou 2000 field parties, and in particu-

lar to Philippe Bouchet (Paris Museum) and to Serge Gofas (University of Malaga) for performing accurate observations and precious sketches about live animals in the field.

I am also indebted to Yves Finet (Geneva Museum) for the pictures of *Gibberula pulchella* syntypes, to Philippe Maestrati (Paris Museum) for the creation of the digital plates, and to Robert and Nicole Hasselot (Jouques, France) for typing out the text.

Guido Poppe (Antwerpen, Belgium) supported the extra cost of the colour pictures.

A special acknowledgement is due to Maxime Desjardins (Paris, France), who deposited the Bavay's marginellids collection in Paris Museum, allowing to revise several taxa in appropriate conditions.

BIBLIOGRAPHY

BAVAY, A., 1917. Quelques coquilles des sables littoraux de divers pays. *Journal de Conchyliologie*, 63 (2): 91-114, pls 2-3.

BAVAY, A., 1922. Coquilles des sables littoraux marins. *Journal de Conchyliologie*, 64 (1): 57-65, pl. 1.

BOUCHET, P., 1994. Atelier Biodiversité Récifale. Expédition Montrouzier. Touho-Koumac, Nouvelle-Calédonie, 23 août-5 novembre 1993. *Rapports de missions, Sciences de la mer, Biologie marine*, ORSTOM-Nouméa, 24: 1-63.

BOYER, F., in press a. Le groupe *Gibberula frumentum* (Sowerby, 1832) dans l'Atlantique occidental. *Novapex*.

BOYER, F., in press b. Description of a new *Cystiscus* (Gastropoda: Cystiscidae) from Mascarene Islands. *Journal of Conchology*.

BOYER, F., in press c. Les genres *Granulina* et *Dentimargo* (Gastropoda: Marginellidae) dans l'infralittoral de la Nouvelle Calédonie. *Novapex*.

COOVERT, G. and COOVERT, H., 1995. Revision of the Supraspecific Classification of Marginelliform Gastropods. *The Nautilus*, 109 (2-3): 43-110.

CROSSE, H., 1871. Diagnoses Molluscorum Novae Caledoniae. *Journal de Conchyliologie*, 19 (3): 201-206.

CROSSE, H., 1872. Descriptions d'espèces inédites de la Nouvelle-Calédonie. *Journal de Conchyliologie*, 20 (3): 218-222, pls 2-13.

GOFAS, S., 1990. Le genre *Gibberula* (Marginellidae) en Méditerranée. *Lavori della Società Italiana di Malacologia*, 23: 113-139.

HEDLEY, C., 1899. The Mollusca of Funafuti, Part I: Gasteropoda. *Memoirs of Australian Museum*, 3 (7): 397-488.

KIENER, L. C., 1834. *Spécies général et Iconographie des Coquilles vivantes. Genre Marginelle*. Pp. 1-30, pls 1-9. J.B. Baillière et fils, Paris.

ROTH, B. AND CLOVER, P. W., 1973. A Review of the Marginellidae described by Bavay, 1903-1922. *The Veliger*, 16 (2): 207-215.

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Ros, J., 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoolgica*, 3 (5): 21-51.

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• Manuscripts must be typed double spaced (including the references, figure captions and tables) on one side on A-4 (297x210 mm) with margins of at least 3 cm. An original and two copies must be submitted. When a paper has joint authorship, one author must accept responsability for all correspondence.

• The authors must include a list of at least 4 possible referees; the Editor can choose any others if appropriate.

• Papers should conform the following layout:

First page. This must include a concise but informative title, with mention of family of higher taxon when appropriatte, and its Spanish translation. It will be followed by all authors' names and surnames, their full adress(es), an abstract (and its Spanish translation) not exceeding 200 words which summarizes not only contents but results and conclusions, and a list of Key Words (and their Spanish translation) under which the article should be indexed.

Following pages. These should content the rest of the paper, divided into sections under short headings. Whenever possible the text should be arranged as follows: Introduction, Material and methods, Results, Discussion, Conclusions, Acknowledgements and References. Unusual abbreviations used in the text must be grouped in one alphabetic sequence after the Material and methods section.

• Notes should follow the same layout, without the abstract.

• Footnotes and cross-references must be avoided. The International Codes of Zoological and Botanical Nomenclature must be strictly followed. The first mention in the text of any taxon must be followed by its authority including the year. In systematic papers, when synonyms of a taxon are given, they must be cited IN FULL, including the periodical, in an abbreviate form, where they were described, and the type localities in square brackets when known. Follow this example (please note the punctuation):

***Dendrodoris limbata* (Cuvier, 1804)**

Synonyms

Doris limbata Cuvier, 1804, *Ann. Mus. H. N. Paris*, 4 (24): 468-469 [Type locality: Marseille].

Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop. Car.*, 10: 275.

These references must not be included in the Bibliography list, except if referred to elsewhere in the text. If a full list of references of the taxon is to be given immediately below it, the same layout should be followed (also excluding those nowhere else cited from the Bibliography list).

Only Latin words and names of genera and species should be underlined once or be given in *italics*. No word must be written in UPPER CASE LETTERS. SI units are to be used, together with their appropriate symbols. In Spanish manuscripts, decimal numbers must be separated with a comma (,), NEVER with a point (.) or upper comma (').

• References in the text should be written in small letters or SMALL CAPITALS: Fretter and Graham (1962) or FRETTER AND GRAHAM (1962). The first mention in the text of a paper with more than two authors must include all of them [Smith, Jones & Brown (1970)], thereafter use *et al.* [Smith *et al.* (1970)]. If an author has published more than one paper per year, refer to them with letters: (Davis, 1989a; Davis, 1989b). Avoid *op. cit.*

The references in the reference list should be in alphabetical order and include all the publications cited in the text but only these. ALL the authors of a paper must be included. These should be written in small letters or SMALL CAPITALS. The references need not be cited when the author and date are given only as authority for a taxonomic name. Titles of periodicals must be given IN FULL, not abbreviated. For books, give the title, name of publisher, place of publication, indication of edition if not the first and total number of pages. Keep references to doctoral theses or any other unpublished documents to an absolute minimum. See the following examples (please note the punctuation):

Fretter, V. and Graham, A., 1962. *British Prosobranch Molluscs.* Ray Society, London, 765 pp.

Ponder, W. F., 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. In Ponder, W. F. (Ed.): Prosobranch Phylogeny, *Malacological Review*, suppl. 4: 129-166.

Ros, J., 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

• Figures must be original, in Indian ink on draughtsman's tracing paper. Keep in mind page format and column size when designing figures. These should be one column (57 mm) or two columns (121 mm) wide and up 196 mm high, or be proportional to these sizes. Two columns format is recomended. It is desirable to print figures with their legend below, so authors are asked to take this into account when preparing full page figures. If computer generated graphics are to be included, they must be printed on high quality white paper with a laser printer. Photographs must be of good contrast, and should be submitted in the final size. When mounting photographs in a block, ensure spacers are of uniform width. Remember that grouping photographs of varied contrast results in poor reproduction. Take account of necessary reduction in lettering drawings; final lettering must be at least 2 mm high. In composite drawings, each figure should be given a capital letter; additional lettering should be in lower-case letters. A scale line is recomended to indicate size, magnification ratio must be avoided as it may be changed during printing. UTM maps are to be used if necessary. Figures must be submitted on separate sheets, and numbered with consecutive Arabic numbers (1, 2, 3,...), without separating 'Plates' and 'Figures'. Legends for Figures must be typed in numerical order on a separate sheet, and an Spanish translation must be included. Follow this example (please note the punctuation):

Figure 1. *Neodoris carvi*. A: animal crawling; B: rinophore; C: gills.

If abbreviations are to be used in illustrations, group them alphabetically after the Legends for Figures section.

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• Fifty reprints per article will be supplied free of charge. Additional reprints must be ordered when the page proofs are returned, and will be charged at cost. NO LATER orders will be accepted.

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La *Sociedad Española de Malacología* se fundó el 21 de agosto de 1980. La sociedad se registró como una asociación sin ánimo de lucro en Madrid (Registro N° 4053) con unos estatutos que fueron aprobados el 12 de diciembre de 1980. Esta sociedad se constituye con el fin de fomentar y difundir los estudios malacológicos mediante reuniones y publicaciones. A esta sociedad puede pertenecer cualquier persona o institución interesada en el estudio de los moluscos.

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ISSN 0212-3010